

EDITORIAL



With 66 % of all Renewable Energy coming from India from the Wind, Wind is the most proven, matured, society accepted technology today. It is a happy occasion to inform the readers that in March 21-22, 2015, NIWE received the Century International Quality ERA Award in the Gold Category recognized for Commitment to Quality,

Leadership, Technology and Innovation, acknowledging strong commitment to quality and excellence from BID Group One of Spain at Geneva Quality Convention 2015, Switzerland.

NIWE also has been dynamic in changing its character from mere Services based Centre to relevant Research and Development based National Institution. NIWE's efforts to launch two important services to the Indian wind industry (i) on the International Accredited Certification of the wind turbine generators in India (ii) wind power forecasting to enable higher penetration of wind energy in Indian grid facilitating the scheduling by the load dispatch centers.

With the small wind turbine testing, a new 15 kW vertical axis grid tied wind turbine is under testing and NIWE has completed power quality measurements of a pitch regulated 225 kW machine. In addition, indigenous design and development of a photonic system (LIDAR) for real time remote monitoring of wind and other parameters has been prototyped and has been tested at Kayathar. The work towards commercializing new "Vertical Wind Profiling System Automated Collimation, Translation and Data Acquisition" in collaboration with M/s GVP Scientific and Industrial Research Centre, Vizakapatnam is under progress.

In order to validate the 80 m level wind potential of 103 GW while launching the Wind Atlas way back in April, 2010, over 73 masts of 100 m height installed at various places in India to facilitate real time data acquisition at multiple levels and to complete the validation of Wind Atlas prediction of wind resource potential.

New MoU has been signed with M/s BITS, Pilani, Goa Campus for academic and research and socio-economic activities during this period.

Two wind turbines, one at Madhya Pradesh and another at Tenkasi have been instrumented and measurements are in progress for type testing as per IEC standards. The measurements will continue in this windy season to collect data for the entire wind speed range.

Standards and Certification has been renewing C-WET / NIWE certifications with verification of documentation and field performance inputs. Two new prototype models have also been recommended for grid connection and testing in India.

NIWE's scientific team is also in discussion with TUV Rheinland Limited and finalizing the joint launch of certification services in India for the benefit of Indian Industry. NIWE is also assisting the Nodal Ministry in finalizing Research proposals for small wind and hybrid development in India and as many as 10 projects which

were closely scrutinized by NIWE's scientific team have been initiated during this period.

The 15th International Training Programme for a period spanning one month under the MEA/ITEC/SCAAP programme has been completed. The programme highlighted practical training with hands on manufacturing with the assistance of M/s MinVayu at Auroville, Puducherry and factory visit to M/s Global Wind Power Ltd at Puducherry and visits to WTTS/WTRS and wind farms at Kayathar. In addition to the International Programme, 17th National Training Course was attended by 43 participants from 13 States of the Country.

NIWE has actively participated in the RE-INVEST 2015 Expo and Conference proceedings organized by IREDA largely assisted by MNRE at New Delhi during 15th to 17th February, 2015. NIWE Scientists actively deliberated and also conducted a dedicated offshore wind power session in the RE-INVEST 2015 Expo. NIWE's stall in RE-INVEST was inaugurated by our Hon'ble Minister (I/c) for Power, Coal and New & Renewable Energy, Shri Piyush Goyal.

NIWE has been a centre of attraction for students, visitors from various schools/polytechnics and engineering colleges and had showcased not only wind energy techniques but also wind & solar resource data analysis techniques.

Under the SRRA programme Dr. Richard Meyer, Managing Director, Suntrace, Germany along with Mr Kausahl Chatbar, Suntrace visited NIWE for up gradation of the SRRA data quality control algorithm during this period.

The green energy corridor development project coordinated by GIZ with the assistance of KFW is actively participated by NIWE scientist and officials.

During this period, NIWE also had detailed discussion along with the Joint Secretary (WE), MNRE, Ms. Varsha Joshi, IAS in a high level meeting with CMD-TEDA, Chairman-TANGEDCO, Energy Secretary, Tamil Nadu and reviewed and studied the operation of SLDC, TANGEDCO, with regard to full evacuation of wind power during the wind season 2015.

NIWE also discussed and initiated a micro-pilot project for ABT metering at Aiyararoothu substation and to expand the same with the Industry sponsorship from IWPA (the Wind Energy Generators) to forecast the entire wind energy at all 134 substations spread over the length and breadth of Tamil Nadu where wind power is pumped into the grid. Detailed project discussions are in progress in this aspect. This would facilitate scientific forecasting to be used for wind power scheduling to enable evacuation in the grid, most of the wind power that is generated in the State.

Foundation Day of NIWE was celebrated with Mr. K.P.Sukumaran, Former Executive Director of C-WET/NIWE as Chief Guest.

NIWE is fully prepared to look at the Industry for delivering most needed services at the time of need to enable wind and solar sector to have hybrid power in the Country since wind and solar is quite complementary in time in most places.

Your valuable criticisms and comments would enable us create more useful capacity building at NIWE with industry interaction.

Dr. S. Gomathinayagam, Director General

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Research and Development

Small Wind Turbine Testing / Empanelment

NIWE completed the review of documentation of first of its kind 15 kW Vertical Axis grid-connected small wind turbine. The testing of the model is scheduled to be taken up during the windy season of April-October 2015. Also, testing of three models of small wind turbines ranging from 2.3 kW to 3.6 kW at WTRS, Kayathar was completed. The 11th Meeting of Committee of Empanelment was conducted and the 12th list of empanelment is likely to be released shortly.



Typical view of 15 kW Vertical Axis grid-connected small wind turbine

Power Quality Measurement on a Pitch regulated 225 kW wind turbine

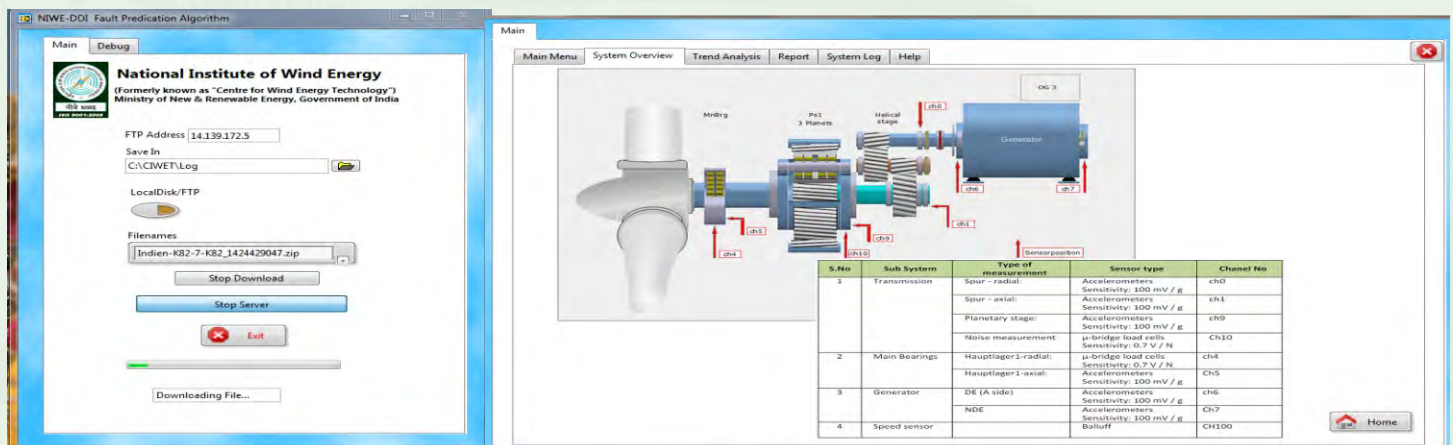
NIWE completed a project collaboration with PRDC on the power quality measurements on a pitch regulated 225 kW wind turbine strictly in accordance with IEC 61400-21, covering voltage fluctuation / flicker and harmonics both for continuous and switching operations. The consultancy report was submitted to the client.



Power Quality Measurements

Health / Condition Monitoring at Experimental R&D wind turbine at WTRS, Kayathar

NIWE with the technical assistance of IIT Madras and M/s DDI Consultant is in the process of developing Fault Prediction Algorithm and software. The software has been installed at NIWE and is kept for internal use for end users' comments for further improvements.



Fault Prediction Algorithm software

Wind Resource Assessment

During the period of January to March 2015, five new Wind Monitoring Stations (WMS) have been established (four in Chhattisgarh & one in Rajasthan) and six wind monitoring stations have been closed down (one in Tamil Nadu, three in Maharashtra, one in Uttarkhand & one in Odisha). Presently, 115 WMS are operational in 15 States and one in Union Territory 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.

- Site Validation & Generation Estimation for three projects.
- Verification of procedure of wind monitoring for 27 sites.
- Wind Power Density Map for three sites.
- Technical Due Diligence for a proposed 178.1 MW wind farm.
- Pre-feasibility study for one site.
- Report on Wind Monitoring Study for one site.

R&D Projects progress in WRA Unit

Design and Development of a Photonic System for real time remote monitoring of Wind and other Air Parameters

As part of second mile stone M/s. G.V.P. Scientific and Industrial Research Centre has submitted a report on

SAMIRA “Vertical Wind Profiling System Automated Collimation, Translation and Data Acquisition”. The Project Monitoring Committee Meeting convened on 25th March 2015 reviewed the report and allowed further process.

Repowering of Existing Wind Farms in Tamil Nadu

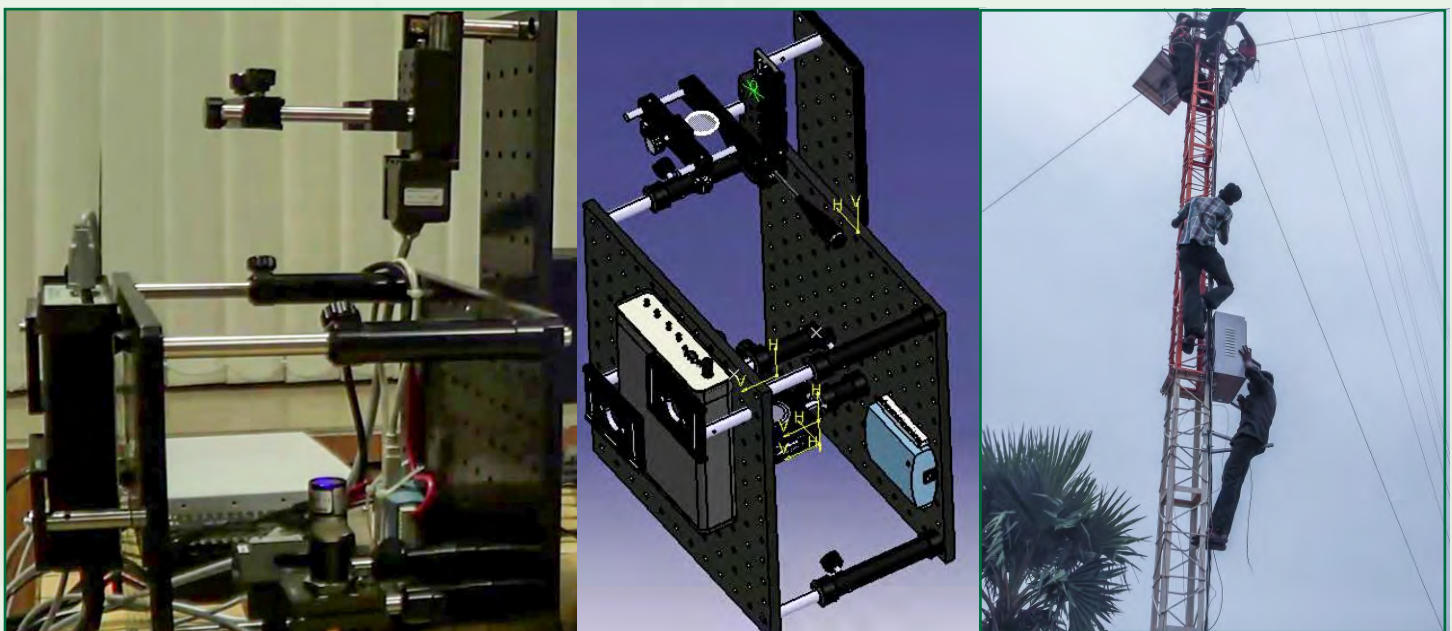
Collection of required wind turbines related information in and around Kanyakumari & Tirunelveli district has been carried out. Required information collection is in progress.

Wind Power Forecasting

- Error analysis of one month generation of Kandamanur site has been carried out.
- Vortex Forecasting error analysis has been carry out.
- Draft NDA with Gujarat Energy Development Agency for providing Wind Power Forecasting service in Gujarat is in progress.

Estimation and Validation of WPP upto 100 m level of seven States in India

NIWE has established 74 (10 in Andhra Pradesh, 12 in Gujarat, 12 in Rajasthan, 13 in Karnataka, eight in Maharashtra, seven in Madhya Pradesh and 12 in Tamil Nadu) WMS under the project 'Estimation & Validation of Wind Power Potential at 100 m level in seven States of India. The data acquisition is in progress.



SAMIRA Prototype

- One year of continuous data acquisition from 48 WMS (seven in Andhra Pradesh, seven in Gujarat, two in Madhya Pradesh, four in Maharashtra, ten in Karnataka, eight in Rajasthan and 10 in Tamil Nadu) have been completed successfully.
- Continuously monitoring and receiving real time wind data from 73 stations in seven States.
- Monthly Data Analysis, Verification and preparation of Interim reports are in progress.

Wind Resource Assessment Studies

- Draft report for M/s. NEEPCO has been forwarded.
- Draft report for three sites in Kerala for M/s. ANERT has been prepared.
- Interim report for Gangavaram Port Trust has been forwarded.
- Interim report for Kudgi for M/s. NTPC has been forwarded.
- Interim report for three sites in Kerala for M/s. ANERT has been forwarded.
- Interim report for Ennore Port has been forwarded.
- Rectification work at Ennore Port has been carried out.
- Final report for M/s. NSL has been prepared.

MoU

- Memorandum of Understanding has been executed between NIWE & BITS, Pilani for the purpose of academic / research / training / socio economic activities and interaction, at NIWE on 19th February 2015.

Other Programmes

- Technical Committee Meeting to evaluate the purchase of Data Loggers, Pressure Sensors & Solar Radiation Sensors for establishment of WMS in Assam for M/s. Oil India Limited has been convened at NIWE on 13th January 2015.
- Mr. J. Bastin, Assistant Director (Technical) visited Karnataka for Technical bid evaluation of 8 MW wind farm development in Karnataka for M/s. BEL, Bangalore during 13th to 14th January 2015.
- Mr. K. Boopathi, Head, WRA, NIWE carried out site visit to file a police complaint against theft of mast materials and to resolve the problem at Subramaniyapuram site in Tamil Nadu during 16th to 17th January 2015.
- Mr. Joel Franklin Asaria, Additional Director & Mr. Krishnan, Assistant Engineer attended prebid

meeting for M/s. Chennai Port Trust, Chennai on 10th February 2015.

- Meeting on finalization of the study report for the project “Repowering & Techno Economic Feasibility Study” for M/s. TNPL Ltd. has been convened at NIWE on 16th February 2015.
- 3rd Technical Committee Meeting to evaluate the received tenders for procurement of Basic Wind Parameters Map for Re-assessment of Wind Potential in India has been convened at NIWE on 19th February 2015.
- Mr. K. Boopathi, Head, WRA, NIWE visited Mizoram to identify the suitable locations for installing SWES in the State of Mizoram during 24th & 25th February 2015.
- Mr. K. Boopathi, Head, WRA, NIWE, Mr. M. Joel Franklin Asaria, Additional Director & Mr. B. Krishnan, Assistant Engineer visited Andaman & Nicobar to carry out Feasibility and logistical study for the proposed wind turbine locations (200 to 250 kW) for M/s. Andaman & Nicobar Administration during 2nd to 10th March 2015.
- Mr. A. G. Rangaraj, Assistant Director (Technical) & Mr. R. Vinod kumar, Junior Engineer visited Arunachal Pradesh and carried out site selection for establishment of WMS in Arunachal Pradesh during 24th February to 8th March 2015.
- 4th Technical Committee Meeting to evaluate the bids and to select the suitable vendor for procurement of Basic Wind Parameters Map for the Re-assessment of Wind Potential in India has been convened at NIWE on 18th March 2015.
- 2nd Project Monitoring Committee Meeting to review the report submitted by M/s. G. V. P. Scientific and Industrial Research Centre on SAMIRA “Vertical Wind Profiling System Automated Collimation, Translation and Data Acquisition” convened at NIWE on 25th March 2015.

SNA / Stakeholders / Wind Turbines Manufactures Meeting

A stake holders meeting was convened on 11th February 2015 in the conference hall of NIWE with State Nodal Agencies (SNAs), Wind turbine manufacturers, Developers, IWPMA, IWPA, MNRE and NIWE officials to understand the bottlenecks in the implementation of the 500 numbers of 100 m level wind monitoring stations under NCEF scheme and to determine the next course of action to be initiated in implementing the scheme. This would facilitate the understanding of the actual requirements of both stake holders & SNAs to implement the scheme more effectively.

Totally, 18 participants from wind turbine manufacturer / developers / Association, eight participants from State Nodal Agency, one representative from MNRE and 11 NIWE officials has attended the meeting.

Dr. S. Gomathinayagam, Director General, NIWE welcomed all the participants and explained the advantages of the scheme and the issues faced by NIWE in implementing the MNRE guidelines. In addition, DG, NIWE informed that MNRE would like to speed up the WRA project throughout the country and explained the purpose of PPP mode to collect the bankable wind data in unexplored areas across the country. He further informed that the main intention of the scheme is to study the Wind Power Potential at 100 m level in 500 locations across the country. Initially, the cost sharing ratio of the scheme was 40 per cent from National Clean Energy Fund, 30 per cent from SNAs and 30 per cent from private industries. However, based on the financial constraint faced by SNAs, government provided relaxation to decide 60 per cent cost sharing by concerned SNA /

Private developer/Industry.

Mr. K. Boopathi, Head, WRA, NIWE made a detailed presentation about the scheme.

Mr. A. Hari Bhaskaran, Principal Scientific Officer, MNRE expressed the importance of the scheme and also he re-iterated that the scheme was framed after due consultation with Wind Turbine Manufacturers, developers, SNAs and Stakeholders. He also informed to all the stakeholders that the Ministry decided to expedite the wind monitoring stations establishment process by involving more private people and stakeholders so that the government shall know the exact or close to exact figure of Wind Power Potential at 100 m level. He requested all the participants to offer frank feedbacks so that MNRE may do suitable amendment in the guidelines.

During the meeting, many Private entities, Stakeholders and SNA raised various queries on MNRE guidelines. DG, NIWE and the Head, WRA clarified all the queries raised.



Wind Turbine Testing

Two projects are in progress for :

- Measurements for Type Testing of XYRON 1000 kW wind turbine at Richadewda, Ratlam District, Madhya Pradesh of M/s. Xyron Technologies Limited are expected to start during windy season of 2015.
- Measurements for Type Testing of GVSL 1700 kW wind turbine at Kampaneari Pudhukudi (Village), Tenkasi (Taluka), Tirunelveli District, Tamil Nadu of M/s. Garuda Vayu Shakti Limited are expected to start during windy season of 2015.

Standards and Certification

- Review / verification of documentation in connection with renewal of Certificate of GWL 225 wind turbine model has been completed. Based on the review / verification, renewed Certificate has been issued to M/s. Southern Wind Farms Limited.



Issuing renewed Certificate to M/s. Southern Windfarms Limited

- An agreement has been signed with M/s. RRB Energy Limited to take up the project on renewal of Certificate of "V 39-500 kW with 47 m Rotor diameter" wind turbine model as per TAPS-2000 (amended). Review / verification of documentation in connection with renewal of Certificate of "V 39-500 kW with 47 m Rotor diameter" wind turbine model is initiated.
- Discussions with officials of M/s. TUV Rheinland India Private Limited in connection with co-operation in the area of type certification of wind turbines are ongoing.
- Review / verification of documentation provided by various wind turbine manufacturers for more than 60 wind turbine models in connection with Revised List of Models and Manufacturers of wind turbines (RLMM) – Addendum – I to Main List have been completed.
- As a part of RLMM process, Head, S&C, NIWE and an Engineer carried out the verification of the manufacturing facility of a wind turbine manufacturer.
- Organized the RLMM Committee meeting.
- RLMM Addendum-I List dated 9th January 2015 finalized by RLMM Committee, has been issued.
- Prepared consolidated list of wind turbine models and manufacturers as on January 2015 and hosted the same in NIWE website.
- Review / verification of documentation provided by various wind turbine manufacturers for more than 55 wind turbine models in connection with Revised List of Models and Manufacturers of wind turbines (RLMM) – Addendum – II to Main List is ongoing.
- Letters have been issued in connection with grid synchronization of three prototype wind turbines of "EX-55 Version: RB XT-27, HH 60 m, 50 Hz" wind turbine model (M/s. Xyron Technologies Limited), based on the earlier requests.
- Review / verification of documentation received from wind turbine manufacturers for facilitation grid connection of proto types as per MNRE guidelines is ongoing.
- Co-ordination works with Bureau of Indian Standards (BIS) in connection with standards related activities are ongoing.
- Participated in detailed discussions on "TEJAM URJA Technology – Power generation projects" at NIWE on 9th February 2015.
- The continual improvement and maintaining the quality management system are ongoing.
- Director General, NIWE, Head, S&C and Engineers had detailed discussions with officials of M/s. TUV Rheinland India Private Limited in connection with cooperation in the area of type certification of wind turbines in a meeting held at NIWE, Chennai.

Wind Turbine Research Station

For the windy season 2015, the complete Operation and Maintenance works like conditioning of power panels, control panels, functionality checks of all the sensors of nine 200 kW MICON Wind Electric Generators and cleaning of transformer oils of nine Transformers were carried out as a part of preparation of the machines for uninterrupted operation, in the wind season 2015.

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

- Three officials from GIZ (Indo German Energy Program), Green Energy Corridors visited on 7th January 2015.
- 20 participants of 15th International Training Programme on “Wind Turbine Technology and Applications” on 26th February 2015.
- 200 students & eight staff members from Three Higher Secondary Schools around Kayathar for creating awareness among students as a part celebrations of “National Science Day” on 27th February 2015.

Information, Training and Commercial Services

15th International Training Programme (one month)

NIWE has successfully conducted the 15th International Training Programme on “Wind Turbine Technology and Applications” during 4th February to 3rd March 2015 addressing 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 Countries sponsored by the Ministry of External Affairs (MEA), Government of India under ITEC / SCAAP programme and supported by the Ministry of New and Renewable Energy (MNRE), Government of India. The course was attended by 20 participants from 13 countries (Afghanistan, Algeria, Bangladesh, Botswana, Fiji,



Glimpses of 15th International Training Programme

Lithuania, Madagascar, Malaysia, Nigeria, Sudan, Syria and Tanzania)

The training was inaugurated by Dr. Ramachandra moorthy, Vice Chancellor, St. Peter's University, Chennai.

During the 28 days of training, 47 classroom lectures were scheduled, which was handed by NIWE scientists and external experts from Wind Turbine Manufacturers, Wind Farm Developers, Consultants, Academicians, Utility and

IPP, individual also practical training at Laboratories and visits to wind farm field and factory to M/s. Global Wind Power Ltd. at Pondicherry, M/s. MinVayu at Auroville (Pondicherry), visit to Kayathar and Kanyakumari Wind Turbine Test Station and Wind Turbine Research Station.

Dr. G. Raghava, Chief Scientist, Structural Engineering Research Centre (SERC), Chennai was the Chief Guest for the valedictory function and distributed the Course Certificates to all the participants.

17th National Training Course (3 days)

17th National Training Course on “Wind Energy Technology” was successfully conducted during 18th -20th March 2015 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. The course was attended by 43 participants from various organisations from 13 States of the country. The course was inaugurated by Dr. E. Sreevalsan, Assistant Vice President, Gamesa Wind Turbines Private Limited, Chennai.

Dr. Purnima Jalihal, Chief Scientist, National Institute of Ocean Technology (NIOT), Chennai was the Chief Guest for the Valedictory Function and distributed the course certificates to the all the participants.



Dr. E Sreevalsan releasing the Course Material



Dr. Purnima Jalihal distributing the course certificate to the participant

Participation in the Exhibitions

NIWE had established and managed its Stall in the following exhibitions to create awareness and share the knowledge about NIWE activities & services to the visitors in various capacities.

- 102nd Indian Science Congress 'Pride of India 2015' Exhibition organized by Indian Science Congress Association at Mumbai University, Mumbai during 3rd to 7th January 2015. NIWE Stall has been awarded as “Best Stall design”.



- 1st Renewable Energy Investment Meet & Expo “RE- INVEST 2015” Expo organized by Indian Renewable Energy Development Agency (IREDA) at New Delhi during 15th to 17th February 2015. Hon’ble Minister of State (I/C) for Power, Coal and New & Renewable Energy, Shri. Piyush Goyal inaugurated the NIWE Stall.



NIWE - IWTMA Knowledge Forum

NIWE & IWTMA jointly has been conducting “Knowledge Forum” on various latest advancements in the field of Wind Energy as a platform to collectively develop the knowledge of the industry & NIWE. Similar to previous events, Knowledge Forum on “Virtual Simulation for Wind Energy” by MSC Software Private Limited, Bangalore organized on 28th January 2015. Various professionals from wind energy, NIWE Scientists & other R&D institutions attended the forum.

Visitors to the NIWE

During the period from January - March 2015, the following visits were coordinated with presentations and explanations on wind energy and its status along with NIWE's activities & services. The campus renewable energy facilities were also explained / showcased in detail.

- 14 students from various schools coordinated by M.S. Swaminathan Research Foundation on 12th January 2015.
- 63 students & 2 staff from Layola - ICAM College of Engineering and Technology on 29th January 2015.
- 25 training participants (Polytechnic Teachers) of National Institute of Technical Teachers Training and Research NITTTR, Taramani on 18th February 2015.
- 16 International participants from University of Georgia, USA coordinated by SRM University on 11th March 2015.
- 25 training participants (Polytechnic Teachers) of National Institute of Technical Teachers Training and Research NITTTR, Taramani on 11th March 2015.
- 34 students & 2 staff from Marg Institute of Design & Architecture Swarnabhoomi (MIDAS) on 16th March 2015.

Engineering Services Division

- Purchase of seven additional cameras has been initiated and installation works to be completed.
- Tender has been opened to set up the Video Conference equipment and facility.
- A committee has been constituted for procurement of 380 kW Solar Photo Voltaic Power Plant at the roof top and the technical bid comparison is in progress.
- Technical bid comparison has been done for procurement of 380 kVA & 62.5 kVA diesel generator. Committee has recommended to open the financial bid.
- Tender has been opened for procurement of Solar Water Pump. Purchase order to be issued.
- Indent for procurement of TNEB Current Transformer (CT) and Potential Transformer (PT) has been submitted as they are required for increasing the load demand from 160 kVA to 200 kVA.
- The construction of the compound wall in front side of NIWE is in progress.
- Re-structuring of LAN networking has been proposed and indent submitted for technical bid opening.

- A Horticultural environmentally benign signage of NIWE has been constructed in front side of the campus.



Horticulture signage of NIWE in front of the campus

Solar Radiation Resource Assessment

- Micrositing for relocation at Sitamau and subsequently relocation of Neemuch SRRA station to Sitamau, Madhya Pradesh was carried out during the period 19th to 27th January 2015.
- Calibration of solar sensors from three Karnataka and six Andhra Pradesh SRRA stations and seven pyranometers under commercial mode were carried out.
- Quality Control (QC) check of Satellite data for remaining 45 locations provided by 3-Tier in connection with the preparation of solar maps was completed and QC statistics report was sent to M/s. Suntrace, Germany for their comments & recommendations.
- Soiling experimental set up has been commissioned at Prathyusha Institute of Technology & Management (PITAM), Tiruvallur and NISE, Gurgaon.
- Soiling experimental data collection was continued to study the effect of soiling of solar sensors.
- Quality controlled data of 15 SRRA stations were provided to 10 clients on commercial mode.

Training Program Conducted by SRRA:

- Training for NISE Officials on SRRA activities were done during the period 4th to 7th February 2015 in NIWE, Chennai.
- “Green Energy Corridor” meeting conducted at NIWE, Chennai on 9th January 2015 and visited Kayathar with GIZ official Dr. Indradip Mitra, Ernst & Young officials Ms. Amrita Ganguly & Mr. K.J.C. Vinod Kumar to explore the SRRA activities in the GIZ project.

Visitors to the Unit

- Officials from GIZ, New Delhi visited SRRA & AMS station and calibration facilities at PITAM, Tiruvallur.
- Dr. Richard Meyer, Managing Director, Suntrace, Germany visited NIWE, Chennai and discussed various quality aspects of solar assessment and satellite data during 18th to 20th February 2015.
- Mr. Kausahl Chatbar, Suntrace, New Delhi visited NIWE, Chennai in connection with the upgradation of the SRRA data quality control algorithm during 2nd to 7th February 2015.

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

Dr. S. Gomathinayagam, Director General

- Standing Parliament Committee Meeting at Bhuj, Gujarat during 5th to 8th January 2015.
- 21st Finance Committee Meeting at MNRE New Delhi on 12th January 2015.
- R&D Project Appraisal Committee Meeting at MNRE New Delhi on 13th January 2015.
- Inauguration of new Business Centre of Romax at Pallavaram on 19th January 2015.
- Meeting of Sub-Group 2 on RE-under the framework of the Indo-German Energy Forum at New Delhi 12th February 2015.
- Hon'ble Minister of State (I/C) for Power, Coal and New & Renewable Energy, Shri. Piyush Goyal, visited Tamil Nadu and had discussions with CMD/TEDA, Chairman/TANGEDCO & Secretary, Energy Department. DG along with Joint Secretary (WE)/MNRE, Ms. Varsha Joshi, reviewed and studied operation of SLDC/TANGEDCO, and had discussion with IWPA along with TANGEDCO officials for 100% Wind Energy evacuation in the grid including possible sale of power to the neighboring States, such as Telengana during 6th & 7th March 2015.
- Mutual collaboration at AMET University on 13th March 2015.
- Special Chief Guest of National Level Workshop-cum-Conference at Jeppiar Institute of Technology on 26th March 2015.
- Board of Research Meeting at Sathyabama University on 28th March 2015.
- XIII Meeting of Academic Council at Kalasalingam University at Srivilliputhur on 30th March 2015.

K. Boopathi, Additional Director & Head, WRA

- Lecture delivered on "Wind Energy potential in Andaman & Nicobar Island" in "Renewable Energy Potential in Andaman & Nicobar Islands" at Port Blair on 3rd January 2015.
- Standing Parliament Committee meeting at Bhuj, Gujarat during 5th to 8th January 2015.

- Meeting at MNRE, New Delhi on 10th February 2015.
- Meeting on Reassessment of Wind Power Potential in India at MNRE, New Delhi on 23rd February 2015.
- Wind Evaluation Committee meeting with Power Secretary, Kerala at ANERT, Trivandrum on 16th March 2015.

Wind Turbine Testing Team

- Ninth Management Review Meeting for ISO/IEC 17025-2005 at NIWE, Chennai on 5th November, 2014.
- Re-accreditation audit ISO/IEC 17025-2005 at WTTS, Kayathar during 1st to 2nd December, 2014.

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

- Meeting on "Bill of Materials Committee" at MNRE, New Delhi during 16th to 17th March 2015.

P. Kanagavel, Additional Director & Head, ITCS

- Lecture delivered on "Wind Energy Technology and Applications" at St. Joseph's Institute of Technology, Chennai on 23rd January 2015.
- Lecture delivered on "Wind Energy Technology and Applications" at National Institute of Technical teacher Training and Research (NITTTR), Chennai on 18th February 2015.
- Lecture delivered on "Energy Efficiency in Library" for UGCASC refresher course at Academic Staff College of the Bharadithasan University, Thiruchurappall on 24th February 2015.
- Lecture delivered on "Wind Energy Technology and Applications" at National Institute of Technical teacher Training and Research (NITTTR), Chennai on 11th March 2015.
- Chief Guest for the Earth Hour Movement Programme conducted in association with WWF India at Sathyabama University, Chennai on 28th March 2015.

M. Anvar Ali, Additional Director & Head, ESD

- Visited Andaman & Nicobar to carry out Feasibility and logistical study for the proposed wind turbine locations (200 to 250 kW) for M/s. Andaman & Nicobar Administration during 2nd to 10th March 2015.

Dr. G. Giridhar, Director & Head, SRRA

- Lecture delivered on "Approaches for Harnessing Technological Development for manufacture" at PSG College of Technology, Coimbatore during 25th - 26th February 2015.
- Lecture delivered in the International Conference on "Innovative Strategies in Renewable Energy and its Application -ISREA' 15" at Sona College of Engineering, Salem on 5th March 2015.
- Lecture delivered in the conference on "National Level Conference on Power Electronic and Drives (PED '15) at Alagappa Chettiyar College of Engineering & Technology, Karaikudi on 11th March 2015.

R. Karthik, Assistant Director (Technical) Contract

- Lecture delivered on Solar Radiation & Solar Technology at Sri Manakula Vinayagar Institute of Technology, Puducherry on 3rd March 2015.

Prasun Kumar Das, Assistant Director (Technical) Contract

- Lecture delivered on Solar Energy Systems for the benefit of LIC Engineers at Ambattur, Chennai on 28th February 2015.

Visits Abroad

- **J. Bastin**, Assistant Director (Technical) participated and presented a paper in the International conference (RESUS 2015) on "Comparison of Merra, Era-Interim Re-analysis wind profile data with Actual measurements in Semi Complex Terrain in India" (authors K. Boopathi, J. Bastin, Dr.S.Gomathinayagam, B. Krishnan) at Universite des Mascareignes, Rose Hill Campus, Mauritius during 3rd to 5th March 2015.
- Business Initiative Group / BIG Group one of Spain has selected NIWE - National Institute of Wind Energy for International Quality ERA Award, Gold Category and the award ceremony attended by DG, NIWE to collect the award at Geneva, Switzerland during 20-22 March 2015.

Publications

Gomathinayagam .S (2015), Repowering of Wind Farms : Issues and proposals in India. *Indian Wind Power*, 1(2), 11.

NIWE Awards & Achievement



NIWE received Century International Quality ERA Award under Golden Category (March 21-22) at Geneva, Switzerland during 20th to 24th March 2015 (Youtube link : <https://www.youtube.com/watch?v=y1qzFfyE16c>)

The following NIWE staff delivered lecture(s) in the 15th International Training Programme on “Wind Turbine Technology & Applications” held during 4th February to 3rd March 2015 and 17th National Training Course on “Wind Energy Technology” held during 18th to 20th March 2015

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

Training / Conferences / Seminars attended by NIWE Scientists

Anuradha Babu, ESO

- Purchase and Disposal Management at Regional Training Centre at Institute of Government of Accounts and Finance at Rajaji Bhavan, Chennai during 8th & 9th January 2015.
- Disciplinary Proceedings and Conduct Rules at Regional Training Centre at Institute of Government of Accounts and Finance, Rajaji Bhavan, Chennai during 20th to 22nd January 2015.

T. Ganeshamoorthi, JEA

- Purchase and Disposal Management at Regional Training Centre at Institute of Government of Accounts and Finance at Rajaji Bhavan, Chennai during 8th & 9th January 2015.
- Leave Rules and Maintenance of Service Books at Regional Training Centre at Institute of Government of Accounts and Finance, Rajaji Bhavan, Chennai during 27th to 28th January 2015.

R & D Unit

Visited Aizwal, Mizoram, for preparation of pre-feasibility report for installation of SWT Hybrid system placed on 23rd February 2015.

Wind Turbine Testing

M. Saravanan and Bhukya Ramdas attended the training on "Mat Lab Fundamentals" organized by M/s. Math Works India Private Limited at Bangalore during 2nd to 4th February, 2015.

Standards & Certification

Additional Director & Head, S&C and S&C Engineer attended the seminar on "Fixed & Floating Offshore Structures - SACS & MOSES applications" organized by M/s. Aryatech Marine & Offshore Services (P) Limited at NIOT, Chennai on 6th March 2015.

Dr. G. Giridhar, Director & Head, SRRA

Workshop on Energy Efficient Solar/Green Building" conducted by HB Management & Engineering Consultants Private Limited at Madurai on 13th March 2015.

Smart Grid Concepts Workshop

All the Unit Heads of NIWE have attended the one day workshop on Smart Grid concepts by iPLON, Chennai at NIWE on 20th January 2015.

IPMA Workshop

M. Joel Franklin Asaria, J. Bastin, B. Krishnan & Bhukya Ramdas attended the Four Day Workshop on "Project Management Leading to Globally Recognized IPMA Level D Certification" organized by International Project Management Association (IPMA) at Hotel Residency, Chennai during 28th to 31st January, 2015.

Rooftop solar best practices Workshop

All the Unit Heads of NIWE have attended the Workshop on "Rooftop Solar Best Practices" organized by TEDA alongwith other senior officials and JS, MNRE at NIWE on 30th January, 2015.

Grid-connected Solar Workshop

All the Unit Heads of NIWE has participated in the Grid-connected Solar Workshop for "Association of Renewable Energy Areas of State (AREAS) at NIWE on 30th January 2015.

RE-INVEST 2015

Dr. S. Gomathinayagam, Rajesh Katyal, David Solomon, Deepa Kurup, K.Boopathi, M.Joel Franklin Asaria, A.G.Rangaraj, J.Bastin, M.C.Lavanya, S.A. Mathew, M. Saravanan, Bhukya Ramdas, A. Senthil Kumar, N. Rajkumar, P. Kanagavel, M. Anvar Ali, Dr. G. Giridhar and R. Sasikumar have attended 1st Renewable Energy Global Investors Meet & Expo "RE-INVEST 2015" organized by IREDA at New Delhi during 15th to 17th February 2015.

WindSIM Training

S. Gomathinayagam, Rajesh Katyal, David Solomon, Deepa Kurup, Naveen Muthu, K.Boopathi, M.Joel Franklin Asaria, A.G.Rangaraj, J.Bastin, M.C.Lavanya, G.Arivukkodi, T.Sureshkumar, B.Krishnan, R.Vinodkumar, S.A. Mathew, M. Saravanan, Bhukya Ramdas and S. Paramasivan, C. Stephen Jeremias attended the 5 days training organized by Mr. Arne R. Gravdahl, CTO & Founder from M/s. WindSIM A/S at NIWE during 9th to 13th March, 2015.

NIWE's FOUNDATION DAY 2015

NIWE's "Foundation Day", 17th Birthday was celebrated third consecutive year on 21st March 2015, with variety of programmes. First time in NIWE history, 'Open Day' was announced for public to visit all the facilities of NIWE on 21st March 2015 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 where in more than 600 students from 30 schools across Tamil Nadu participated in the competitions. Shri K.P. Sukumaran, Former Advisor, MNRE and former Executive Director, NIWE delivered a 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 awards to the winning student as well as the awards and souvenirs to the NIWE Staff.



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



Glimpses of Foundation Day

THE RELEVANCE OF WIND ENERGY SYSTEM IN THE INDIAN ENERGY SCENARIO

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ABSTRACT

The concern about the depleting fossil fuel resources, their impact on the environment, the opposition to the nuclear energy, quest to supply cheap, quality, economical power to the consumer, the need to fill the gap between supply and demand, need of electrical energy in the remote places which are not covered by grids have compelled to go for exploitation of renewable energy. The renewable energy include hydro, wind, solar, geo-thermal, tidal power and ocean energy of which larger hydro systems are classified as conventional energy. In India, the aim is to exploit as much wind and solar energy as economically feasible and possible. There is good potential of wind energy in many states especially Tamil Nadu, Gujarat, Karnataka, Andhra Pradesh and many states. The hot climate of India provides scope for large scale exploitation of solar energy especially in Gujarat and many are following. This article discusses the relevance of wind energy in the state of Tamil Nadu.

KEYWORDS

SCIG – Squirrel Cage Induction Generator; WRIG – Wound Rotor Induction Generator; DFIG – Doubly Fed Induction Generator

1. INTRODUCTION

Tamil Nadu state is always power hungry due to need for well irrigation, presence of large scale industries especially automobile, textile, cement, engineering and power intensive chilling plants and increasing domestic loads. The state has a mixer of hydro, thermal, nuclear and wind energy resources. The state has already exploited hydro stations, has its own coal based thermal power station, which depends on coal imported from other states and also other countries, thermal stations owned by the central and joint (central and state) sectors, thermal stations owned by private operators, gas turbine and naphtha stations for peak load management, Kalpakkam and Koodankulam nuclear stations owned by the central sectors, wind mills in Kanyakumari, Tirunelveli, Tiruppur and Coimbatore Districts mostly owned by private owners and emerging Solar PV Stations. Captive Power Plants and Bio mass stations are also contributing to the state's energy needs. The state has a 400 MW pumped storage plant and a further scheme in the Nilgiris district is on the anvil. The states own resources are insufficient and it imports its share from central stations in other southern states in which it has a share like Kaiga Nuclear Station, Ramgundam Thermal Stations etc. The state grid is covered by an extensive grid consisting of 400 kV, 230 kV and 110 kV lines and substations, supported by a communication network consisting of Power Line Carrier Communication (PLCC) and Fiber Optic Network and Supervisory Control and Data Acquisition (SCADA). There is an ambitious plan to tap wind and solar power by roof top grid connected installation in buildings and also large solar and wind farms and these are slowly picking up. The pumped

storage system can be used to smooth out the variation in the wind and solar energies; operating on pump mode when there is an excess and on generator mode when there is shortage.

Table. 1 indicates the installed capacity and the peak load reached so far during 2014 [1]. Table. 2 shows the energy consumed data along with the energy contribution by wind sources in the state for the year 2014 calculated based on the data collected from [1,2]. The power system supply position for the Southern Grid as per data from [2] for 20-06-2014 is given in Table. 3. Due to strict grid discipline requirements in the Southern Regional grid, the frequency is hovering around 50 Hz and whenever the frequency goes down load shedding is resorted to maintain the frequency.

The following conclusions are drawn from the Table. 1, Table. 2 and Table. 3 are summarized as follows.

In the case of Tamil Nadu at peak load, the wind contribution is $3520/13288 = 26.49\%$ on 26/06/2014. The wind energy share is less than 5% for the months of Jan, Feb, Mar, Apr, Oct, Nov, Dec/2014 and is more than 10% for May, Jun, July, Aug, Sept/2014. The average contribution is 10.10% with energy of 9398 MU. It can be seen that in the months May-Sep/2014, the wind plants have acted as base load stations (contributing of course with the minute to minute vagaries of wind).

The above trend in the case of Tamil Nadu is also observed for the Southern Region with a wind contribution of $119.6/772.7 = 15.47\%$ for 20/06/14. The major contributor is Tamil Nadu ($78.73/772.7 = 10.18\%$) followed by Karnataka ($29.32/772.7 = 3.78\%$) and Andhra Pradesh ($11.05/772.7 = 1.43\%$).

Table. 1 Tamil Nadu Peak Load Details as on 20/06/2014

S. No.	Particulars	Capacity (MW)	Peak (MW) on 20/06/2014
1	TNEB		
	a. Hydro	2284	794
	b. Thermal	4060	2785
	c. Gas	516	184
2	INDEPENDENT POWER PLANT		
	(i) High cost	542.16	907
	(ii) Low cost	416	
3	CAPTIVE POWER PLANT		
	(i) CPP (Direct)	63.5	0
	(ii) CPP (Purchase)	970	779
	(iii) CPP (Others)	910	293
	NON-CONVENTIONAL ENERGY SCHEMES		
	(iv) Co-gen	659.4	88
	(v) Bio mass	215.4	14

S. No.	Particulars	Capacity (MW)	Peak (MW) on 20/06/2014
4	TNEB wind Private wind	17.465	3520 7327.44
5	CENTRAL GENERATING STATIONS		
	a. Neyveli TS1	475	180
	b. Capacity	TNEB SHARE	3056
	(i) NTPC (2600+2000)	910	
	(ii) Neyveli TS2 (1470)	480	
	(iii) Neyveli TS1Expn (420)	226	
	(iv) Talcher (2000)	498	
	(v) MAPS (440)	332	
	(vi) KAPS (880)	234	
	(vii) Vallur (1000)	715	
	(viii) Koodankulam (1000)	562	
6	External Assistance		28
7	Power Purchase TOTAL (MW)		661 13288
	Energy consumed for the day (MU)	293.969	

Table. 2 Tamil Nadu Wind Energy Contribution for the year 2014

Month	Wind-Gen (MU)	Grid Consumption (MU)	Percentage of wind generation
Jan-14	275.458	7577.464	3.64
Feb-14	205.932	7047.516	2.92
Mar-14	295.746	8117.778	3.64
Apr-14	253.947	8167.487	3.11
May-14	837.215	8146.216	10.28
Jun-14	2044.734	8350.859	24.49
Jul-14	2116.637	8496.98	24.91
Aug-14	1522.584	7994.671	19.04
Sep-14	1223.588	7912.56	15.46
Oct-14	289.882	7168.008	4.04
Nov-14	149.323	6868.937	2.17
Dec-14	183.011	7163.51	2.55
Total	9398.057	93011.99	10.10

Table. 3 Southern Grid Power Position for 20/06/2014

State	Thermal	Hydro	Gas/Naptha Diesel	Wind	Others	NET SCH (From Grid)	Drawal (From Grid)	Availability	Demand	Short-age
Andhra Pradesh	77.77	3.12	20.03	31.05	0.16	17.6	20.3	129.73	132.43	14.81
Telangana	42.47	0.0	0.0	0.0	7.03	69.69	69.47	119.19	118.97	4.4
Karnataka	39.17	27.88	19.17	29.32	16.94	29.71	31.79	162.19	164.27	9.24
Kerala	0.0	15.77	3.8	0.5	0.27	32.71	34.68	53.05	55.02	0.58
Tamil Nadu	79.22	5.42	17.72	78.73	28.94	84.48	84.88	294.51	294.91	0.3
Pondy	0.0	0.0	0.0	0.0	0.0	0.0	7.16	7.16	7.10	0.01
Total	238.63	52.19	60.72	119.6	53.34	241.35	248.22	765.83	772.7	29.34

2. POWER QUALITY ISSUES

A. Wind Power Impact

The impact of wind power in the electric power system depends on the following:

- Wind power penetration level
- Grid size
- Generation mix in the power system

Penetration of less than 5 %	- not an issue to the grid operator
Penetration more than 10 %	- grid adaptation and remedial measures are needed
Penetration more than 20 %	- strengthening of existing grid becomes essential

In the state of Tamil Nadu the wind penetration has already crossed 24 % and in the case of Southern Grid it has already crossed 15 % penetration and is likely to increase in future. Necessary measures are to be taken to ensure power quality. At present, most of the wind generators in Tamil Nadu are of induction generator type although Doubly – Fed Induction Generator (DFIG) and Permanent Magnet Synchronous Generators (PMSGs) are also available. This article also examines the issues connected with Power Quality (PQ) and mitigation techniques. The following contents discuss the various types of Wind Power Plants (WPP) and how these contribute to PQ in combination with Flexible AC Transmission System (FACTS) devices and storage methods.

B. Classification of Wind Power Plants (WPPs)

A. Constant Speed WPPs

Type-A - SCIG, directly connected to the electric grid through a soft start

Type-B - WRIG, the stator is directly connected to the grid. The copper winding of the rotors are connected to external variable resistors

B. Variable Speed WPPs

Type-C – DFIG, the stator is directly connected to the grid. The rotor is also connected to the grid through Power Electronic Control (PEC) devices.

Type-D - There are eight types.

- Type-D - Geared WPP with variable speed SCIG and full rated PEC
- Type-D - Geared WPP with variable speed WRSG and full rated PEC
- Type-D - Hydro dynamically geared WPP with Constant speed WRIG
- Type-D - Geared WPP with variable speed PMSG and full rated PEC
- Type-D - Hydro dynamically geared WPP and constant speed PMSG
- Type-D - Direct drive WPP with variable speed and full rated PEC
- Type-D - Direct drive WPP with variable speed PMSG and full rated PEC
- Type-D - Hybrid (semi-geared) WPP with variable speed PMSG full rated PEC

C. Features And Limitations of WPPs

1. Constant Speed WPPs

Features:

These are of simpler construction induction generators and are available off the shelf. They have excellent electrical and mechanical characteristics, don't have hunting problems, reduce short circuit power of the station, contribute inertia to absorb wind gusts, less sensitive to grid abnormalities, have simpler controls and the size is only about one-tenth of a synchronous generator.

Limitations:

- These SCIGs and WRIGs consume reactive power due to the magnetizing current supplied by the grid to the stator winding which results in low power factor, thereby requiring compensation devices to be used.
- These WPPs are more successful only in strong grids.
- Generally, these WPPs do not have Fault-Ride-Through (FRT) property.
- They cannot provide voltage or frequency control due to narrow range of speed control.

2. Variable Speed WPPs

For increasing the annual energy yield, it is necessary that the WPP generates over a wide wind speed range. Also, it is desirable to control active and reactive power from the WPP. This has become possible by invention of various types of variable speed WPPs using

electrical generators controlled by power electronic converters.

Based on the speed variability, two major categories of variable speed WPPs are as follows:

- Type-C WPP for limited range variable speed
- Type-D WPP for wide range variable speed

The mechanical rotor speed and the electrical frequency of the grid need to be decoupled to allow variable speed operation. The various topologies incorporated in variable speed WPPs are available.

Effects of Variable Nature of the Wind Speed on Grid Operation

The variable nature of wind speed often creates small imbalance which leads to degradation of PQ and due care is to be taken. The threats to stability of the power system are generally not due to WPPs.

Single WPPs: Have fast, autonomous self protection regulations of their terminal voltage and they respond rapidly and correctly for grid voltage events.

Wind Farms: Wind Farm Management System (WFMS) and Wind Power Management Software/ SCADA provide controls to meet performance requirements i.e. voltage regulation at PCC by

- Sending reactive power commands to single WPP
- Coordinating other substation equipment (e.g. shunt capacitor)
- Interfacing with utility SCADA
- Accepting utility system operator commands (e.g. voltage reference set point)

Power Quality

Constant Speed WPPs pass on the cyclic PQ variation to the grid network and need for correction arises if the limits are violated.

Variable speed WPPs produce steadier power quality issues. Many of the fast variations are not transmitted to the grid network, but are smoothed out by flywheel action of the wind turbine rotor or the PEC.

An alternative is to configure the WPPs as an integrated energy system for operation in conjunction with other renewable energy sources, traditional energy sources and/or storage elements (wind-diesel, wind-SPV-Diesel and wind powered pumped storage system). A near constant output power can be obtained by proper design. The grid connected and standalone modes can also be used as an alternative.

Overview of Grid Power Quality due to WPPs

The quality issues in the case of wind power can be divided into local and system wide effects [3-14]. The following Tables. 4 and 5 indicate the local and system wide issues and how they can be mitigated in the case of the different WPP's.

ISLANDING

If a section of a grid is isolated (islanded) from the rest of it and if

1. Local Effects

Table. 4 Overview of Local Impact on Wind Power and Mitigation

S.No.	Local Impacts	Type-A and Type-B WPP	Type-C WPP	Type-D WPP
1.	Changes in node voltages and branch flows	Occurs but compensation but possible with capacitor banks, SVCs/STATCOMS	Compensation possible but dependent on PEC rating	Compensation possible but dependent on PEC rating

S.No.	Local Impacts	Type-A and Type-B WPP	Type-C WPP	Type-D WPP
2.	Fault currents and protection schemes	Protection possible with conventional protection schemes and mechanical torque limiters	Protection possible till PEC limit and then immediately disconnected	Protection possible till PEC limit and then, immediately disconnected
Power Quality				
3(a)	Slow voltage variations (steady state)	Present but not disturbing	Unimportant because the PEC in rotor circuit acts as an energy buffer	Unimportant because the PEC in stator decouples the generator from the grid
(b)	Rapid voltages (Flicker) (steady state)	May occur particularly in weak grids	Unimportant because the PEC in rotor circuit acts as an energy buffer	Unimportant because the PEC in stator decouples the generator from the grid
(c)	Transients	Present	Present to a lesser extent	Present to a lesser extent
(d)	Harmonics	Not present	Not present in modern WPPs	Not present in modern WPPs

2. System wide effects

Table. 5 Overview of System Wide Impact on Wind Power and Mitigation

S.No.	Capabilities	Type-A WPP	Type-B WPP	Type-C WPP	Type-D WPP
1.	Reactive Power compensation and voltage control	Possible with shunt capacitor, SVC/ STATCOM/DVR	Possible with shunt capacitor, SVC/ STATCOM/DVR	Possible with PECs	Possible with PECs
2.	Short term balancing power control and frequency	By blade pitching and WPPs being switched in and out	By blade pitching and WPPs being switched in and out but a little more better	By blade pitching and /or PEC control and WPPs being switched in and out	By blade pitching and /or PEC control and WPPs being switched in and out
3.	Long time balancing output power availability	Possible only to some extent due to stochastic nature of wind	Possible only to some extent due to stochastic nature of wind	Possible only to some extent due to stochastic nature of wind	Possible only to some extent due to stochastic nature of wind
4.	Contribution to fault current	To some extent	To some extent	Difficult beyond thermal limit of PEC, as it may be damaged	Difficult beyond thermal limit of PEC, as it may be damaged
5.	Fault-Ride-Through (FRT) capability	Depends on wind speed, fault duration, grid strength and hence, voltage instability risk exists	Depends on wind speed, fault duration, grid strength and hence, voltage instability risk exists	Difficult beyond thermal limit of PEC, as it may be damaged	Difficult beyond thermal limit of PEC, as it may be damaged

the WPP/wind farm continues to function as a power source on that section of the grid, then this phenomenon is called islanding. In such a condition, the system voltage rises or decreases creating an unbalance between the reactive power production in the grid and consumption of reactive power by WPP(s).

The islanding causes

- Possible voltage problems because of reduced reactive power reserved in the islanded network
- Power reduction in the WPP due to low voltages that can make the situation worse

- Frequency drops faster, resulting in increased load shedding
- Total generation (synchronous + wind) remains constant
- Inertia is reduced

WPP ELECTRICAL SAFETY AND GRID

Every WPP is mandatorily equipped with some basic essential electrical protective provisions and some critical features are duplicated to address the system wide impact. Some of them are as follows.

- Active Power control of WPP/wind farm
- Over frequency
- Under frequency
- Overvoltage
- Under voltage
- Loss of mains
- High over current short circuits
- Earth fault
- Neutral voltage displacement for stability during grid faults
- Thermal overload
- Auto reclosing especially required for large WPPs/wind farms
- Remote control of all the above operation

CONCLUSIONS

Wind power has made rapid inroads into the energy sector in view of their cleaner, abundant, cheaper and distributed nature and also due to the idiosyncrasies of the fossil and nuclear power sources. However, they are periodical and varying in nature and these may reflect in the power quality of the energy supplied to the consumer. The penetration of wind energy in the state of Tamil Nadu and Southern Region is examined and it is construed that PQ issues are to be addressed. Constant speed WPPs have their own limitations and variable speed WPPs can address the power quality issues along with FACTS devices. Storage techniques like pumped storage, and other efficient means and islanded operations in the case of grid emergencies can also contribute to the power quality issues. The wind energy can be combined with other sources like solar PV and diesel generator etc., to supply a near constant power supply.

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Published by :

NATIONAL INSTITUTE OF WIND ENERGY (NIWE)An autonomous R&D Institution under the Ministry of New and Renewable Energy (MNRE), Government of India
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