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EDITORIAL

Wind installed capacity surpassing 27 GW, we still have to work hard to reach an annual capacity addition of 5.5 GW per year to reach 60 GW target, for which there is a positive support from Government of India. Several promotional policies have already been released like wind-solar hybrid, and possible demonstration of bidding in wind industry which are likely to enhance the capacity addition in fast track mode inspite of competing Technologies, like Solar.

The recent tour to Berlin Energie Wende, 2016 explored the ambitious plans of Germany going fully renewables by 2030 and we understand US, Canada and Mexico have committed to have 50% their energy from renewable by 2025.

India's ambitious plan of 175 GW renewable energy should expect significant export possibilities of wind energy equipment across the World since it is being manufactured (at least Nacelle Assembly) in India with Internationally Accredited Certified Quality at an affordable International price, by over 21 manufacturers.

India is proud to have this orderly development of wind energy sector standing 4th in installed capacity in the World and 2nd in manufacturing of wind turbine equipment. More acceptability of wind power is likely to continue in every State if wind power forecasting and scheduling is implemented as it has been done in Tamil Nadu for 7400 MW. Such scheduled wind power enables to take up the maintenance activity of thermal power plants/units, Hydro electric power plants and Gas plants and it would also facilitate more penetration of wind power in the energy mix in the state utility grids.

NIWE has been continuously working with National Load Despatch Centre and Southern Regional Load Despatch Centre to facilitate higher and reliable grid stability with increased power quality as mandated by CEA/CERC notification on LVRT compliance.

NIWE has been consistently working on capacity building in Internationally Accredited certification of wind turbines along with TUV Rheinland, Germany. In addition, renewal of certification has been taken up for prior Certified wind turbines of sub-megawatt class.

To establish first offshore LiDAR at Gulf of Khambhat, the offshore division of NIWE has already awarded the contract and the contract execution is in progress.

The LiDAR supplied by FOWIND is under calibration with mast data. Wind Resource Assessment has been a continuing process at NIWE, with a few more 100m masts commissioned in addition to the existing 75 masts in 7 States to gather data upto 100 m level.

After completion of the measured data for wind power, about 35 wind monitoring Stations have been closed down. Presently there are 79 wind monitoring stations which are still operational in 14 States and in one Union Territory.

3 Small wind turbines have been taken up for Testing by NIWE. The accuracy of wind power forecasting and scheduling has been continuously improving. Based on the learning in the last wind season we are able to continue wind power forecasting and scheduling 2nd year in succession for IWPA who are financing the project.

Owing to significant focus for the North East Region, NIWE has taken up special projects for WRA with additional budget provision.

Two power curve measurements and one type testing project have been completed by wind turbine testing as per the International Standards. The single window due diligence committee well known as RLMM committee has been working hard to release the main list during this period. NIWE's Standard & Certification is also focusing on new developments with regard to IECRE systems.

The projects at wind turbine Research Station at Kayathar has attracted several visitors during this period including the Solar Energy Corporation of India, M.D., Mr Ashwini Kumar who will be incharge of the first CTU connected 1000 MW of wind power projects which would be developed in India using BiT mode (Bid in Tariff) as against the current wind power projects coming up with FiT (Feed in Tariff)

Two international training programmes & two National training programmes are being planned by NIWE during this period. Several International researchers have worked at NIWE on several areas including Solar and wind, under RTF-DCS and ISRF fellowship schemes.

Global Wind Day had hosted celebrations with school children, scientific staff alongwith industry sponsored programme with Vestas “Hands on Sand”. During Global Wind Day this time a celebration was also carried out at Vedaranyam down south in Tamil Nadu, District in the coastal village.

A new 2.5 kW wind solar hybrid system has been erected in the roof of NIWE. Solar Radiation Resource Assessment has been taking series of professional training programmes in collaboration with Industry and also planning solar power forecasting for the entire India with the association of GIZ.

Knowledge Sharing and Management has attracted several undergraduates (15) and postgraduates (5) to complete their final year project working in NIWE. Using the infrastructure available in NIWE, about 16 students have completed summer internship at the KSM Unit of NIWE.

Several invited lectures have been delivered by NIWE officials in external forum as well as internal course programmes and citation & puraskar for Hindi, Education leadership award for NIWE are a few achievements worth mentioning during this period.

To facilitate small wind energy systems market, a 20m level wind speed map has been released, derived from the online GIS 100m level map. We would like to welcome constructive criticism and expectations from NIWE to serve you better in future.

Dr. S. Gomathinayagam, Director General

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Offshore, Small Wind Hybrid System & Industrial Business

Offshore activities

(i) Establishment of Offshore LiDAR at Gulf of Khambhat

NIWE is in the process of establishing a sub-structure platform for assessing the offshore wind by LiDAR measurement at Gulf of Khambhat off Gujarat coast. This is an outcome of NIWE's technical cooperation to support the FOWIND project aimed at developing a roadmap for offshore wind development in India. The design and technical specifications for the offshore platform has been finalized by NIWE in association with National Institute of Ocean Technology, Chennai. The tender for the same was floated and the contractor for executing the work has been finalized. The detail engineering drawings of the structure have been prepared by the contractor and fabrication work is in progress.

LiDAR operation demo and training at NIWE office, Chennai

The process of obtaining necessary clearances from the various departments is initiated. The installation and commissioning of the sub structure is expected to be carried out during September 2016 after the end of the ensuing monsoon season as the sea becomes rough and no activity is allowed during the period.

(ii) Validation of Offshore LiDAR

As per the MoU signed with FOWIND, NIWE is in the process of validating the LiDAR for offshore wind resource assessment at Gulf of Khambhat. Training was imparted to the NIWE staff for the operation of the LiDAR. The LiDAR measurements are currently being validated against the 120m met mast data at WTRS. The study will help in determining the accuracy of LiDAR data against the met mast which will help in ensuring reliable data during offshore measurement campaign.

Testing of Small Wind Turbines

NIWE has taken up three new assignments for testing of small wind turbines during 2016. Two of the turbines have been installed at Wind Turbine Research Station (WTRS), Kayathar and testing is under progress. One of the models is a grid connected turbine, the first of its' type being tested by NIWE. The third model, WINDSTREAM will also be taken up for testing during this windy season.

Wind Resource Assessment

Presently, 79 wind-monitoring stations are operational in 14 States and 1 Union Territory under various wind monitoring projects funded by the Ministry of New and Renewable Energy (MNRE) as well as various entrepreneurs. During the period of April to June 2016, 35 Wind monitoring stations have been closed down (4 in Maharashtra, 6 in Gujarat, 9 in Karnataka, 5 in Rajasthan, 8 in Tamil Nadu, 1 in Telangana, 1 in Pondicherry & 1 in Madhya Pradesh).

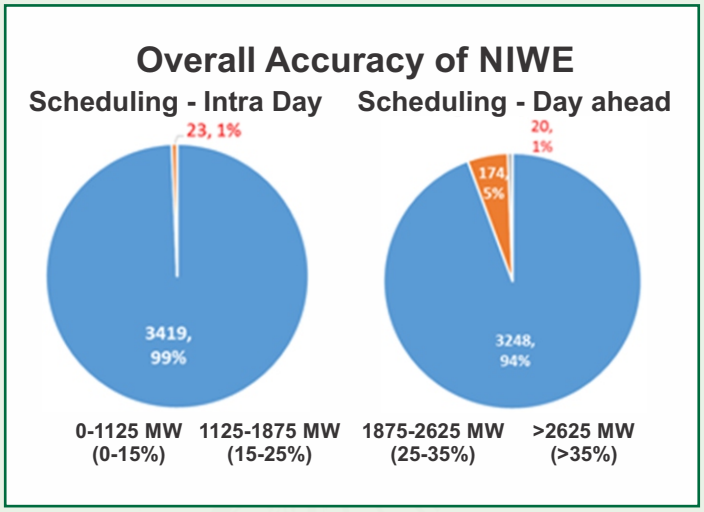
The following consultancy projects have been completed and reports have been submitted during this period:

- Verification of procedure of wind monitoring for 16 sites
- Energy Estimation for the proposed 90 MW wind farm
- Repowering / inter cropping of existing wind farm
- Technical Due Diligence of the proposed 44 MW wind farm
- Data analysis, Micrositing & Annual Energy Estimation of the proposed 68 MW

Wind Power Forecasting services

- Finetuning of numerical prediction system has been carried out.
- Finetuning of wind speed forecasting model using WRF has been carried out.
- Development of an Algorithm on optimizing day ahead wind power scheduling has been carried out.
- Initiated scheduling services, in real time.
- Dedicated system has been created to view latest scheduling in Tamil Nadu State Load Despatch Centre (TNSLDC).
- Created algorithm to generate daily generation report.

- Day ahead algorithm modification has been completed.
- Based on the successful completion of Wind Power Forecasting services for one year period, Indian Wind Power Association (IWPA) has extended the same for the next one year period.
- The Accuracy level of Day ahead Scheduling is 94 % and Intraday scheduling is 99% as given below:



Intra Day & Day ahead Scheduling Accuracy

WRA in Uncovered / New Areas 2015-16 & 2016-17

- Site selection has been carried out in all NE region States.
- Site selection has been carried out in the State of Chattisgarh.

R&D Projects progress in WRA

A 50m wind monitoring station was commissioned at Aarupadai Veedu Institute of Technology, Chennai and data acquisition is in progress.

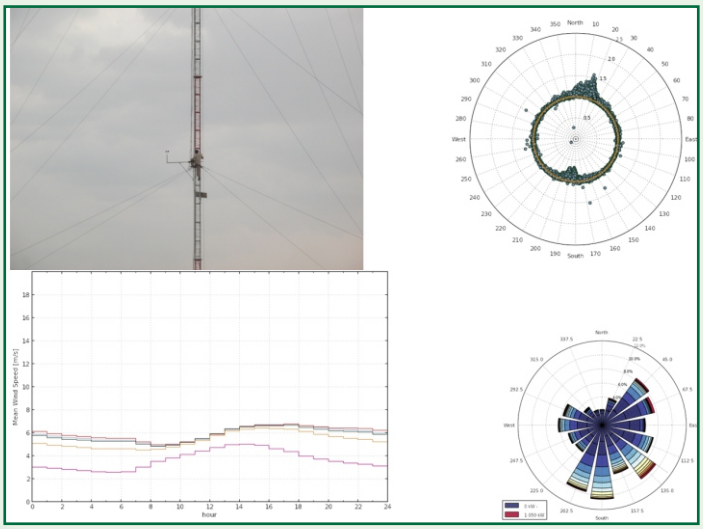
Design and Development of a Photonic System for real time remote monitoring of Wind and other Air Parameters

Gayatri Vidya Parished-Scientific and Industrial Research Centre (GVP-SIRC), Visakhapatnam has handed over the instrument "SAMIRA" and initial validation has been carried out towards further development.

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

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

- One year continuous data acquisition from 69 nos. of WMS (10 in Andhra Pradesh,12 in Gujarat, 4 in Madhya Pradesh, 7 in Maharashtra, 13 in Karnataka, 11 in Rajasthan and 12 in Tamil Nadu) and two year continuous data from 48 WMS (11 in Karnataka, 1 in Madhya Pradesh, 6 in Gujarat, 11 in Tamil Nadu, 4 in Maharashtra, 9 in Andhra Pradesh & 6 in Rajasthan) has been completed successfully.
- Continuously monitoring and receiving real time every 2 seconds interval wind data from 24 stations in 7 States.
- Monthly Data Analysis, Verification and preparation of Interim reports are under progress.



- Dismantling of Sensors and Mast from 51 nos. of WMS are under progress.

Wind Resource Assessment Studies

Installation & Commissioning of one 100m WMS for M/s. Kandla Port Trust has been carried out.

Other Programmes

- Meeting on Wind Power Forecasting services with IWPA/TNEB officials was convened at NIWE, Chennai on 11th April 2016.
- Monitoring Committee Meeting on " Design and Development of Photonic System for real time remote monitoring of Wind and other Air parameters" has been convened at NIWE, Chennai on 22nd April 2016.
- Review Meeting on Wind Power Forecasting with IWPA officials had been convened at NIWE, Chennai on 5th May 2016.
- First meeting of the NE region Wind Resource Assessment Cell had been convened at NIWE, Chennai on 6th May 2016.

- Meeting on Wind Power Forecasting Services with IWPA, TNEB officials had been convened at NIWE, Chennai on 12th May 2016.
- Technical Committee Meeting to determine the selling cost of time series wind data of 100m was convened at NIWE, Chennai on 3rd June 2016.
- T. Sureshkumar, Assistant Engineer carried out site inspection work at Bhuj, Gujarat for Kandla Port Trust during 5th to 7th April 2016.
- B. Krishnan, Assistant Engineer & R. Vinodkumar, Junior Engineer carried out site visit in Perungudi & Kalunirkulam sites, Tirunelveli district to study the pass effect on Wind flow pattern towards installation of 50m WMS from 27th to 29th April 2016.
- A. Haribhaskaran, Deputy Director (Technical) carried out site visit in connection with installation of windmill & Small Hybrid system at Defence Institute of High Altitude Research (DIHAR), DRDO in Leh during 9th to 11th May 2016.
- A. Haribhaskaran, Deputy Director (Technical) & J. Bastin, Assistant Director (Technical) had discussion with Dr. Rudramoorthy, Principal, PSG college of Technology, Coimbatore in connection with installation of Urban Wind Monitoring station on 20th May 2016.
- R. Vinodkumar, Junior Engineer carried out site selection for Urban Wind Monitoring at KCG college of Technology, Karapakkam on 20th May 2016.
- J. Bastin, Assistant Director (Technical) & R. Vinodkumar, Junior Engineer carried out site selection for installation of 80m mast at Manamelkudi, Ammapattinam & Kattumavadi on 26th May 2016.

Wind Power Forecasting

In order to utilize the maximum of renewable resource and to increase the evacuation of wind power generation, a demo 51 MW wind power forecasting project was initiated in 2013 in association with Vortex Spain through an Indo-Spanish collaboration facilitated by MNRE, Government of India.

NIWE has collected wind generation data from various wind farms connected to substations (102 substations) across the State through GPRS and work with Vortex to arrive wind power generation estimation for the following day up to 10 days ahead. Initially, the historical data have been collected and are formatted in a specific form and fed into the software model developed by NIWE. NIWE has created an automated system to pick up and process the real-time generation data which are being received at 15 minutes interval. This processed input is continuously fed into the forecast model developed by Vortex. In addition to the above inputs, the software model has been configured to capture the current atmospheric data (NWP – Numerical Weather Prediction) and using the real-time generation data. It refines the forecast result for the next 10 days for every one and half hour interval as per CERC norms in vogue. The above process is being done for each sub-station. At every one and half hour interval these individual files are integrated into a single file, from which consolidated forecast (MW of Wind Power) for the entire State, is delivered to 'TANGEDCO'. In addition, NIWE created indigenous developed data quality check / processing algorithm and Forecast refinement algorithm to further reduce the NWP uncertainty errors 30-40 % to 6-10 % during Low windy season, as per CERC norms in vogue.

The forecast is being done based on wind data obtained from a European Metrological Agency (ECMRWF-European Centre for Medium range Weather Forecasting). This involves getting satellite data of the prevailing weather condition (present and predicted) where all the wind turbines are located. The data, along with the height of the wind turbine and the wind pattern, is then analyzed and the predicted wind power generation is sent to SLDC, RLDC and various stakeholders.

Highlights of the project

NIWE forecast is first largest single regional forecast with 7.4 GW of Wind by any forecast service provider in the world. This project is one of the successful industry relevant deliverable from an International Co-operation between India and Spain. Since 24th March 2016, apart from wind power forecasting, NIWE is offering Forecasting and Scheduling services to Tamil Nadu SLDC.

In order to extend the same kind of service to all the windy States to absorb the maximum wind Energy, NIWE needs the following technical information:

- Substation Information, WTG / Wind Farm details, Historical generation data, Historical Wind Speed information, if available
- Real time generation data and real-time distribution load consumption data, Wind Speed details, if available
- Distribution load details, in case of mixed feeder Substation etc.

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Wind Turbine Testing

- An agreement was signed between NIWE and M/s. Xyron Technologies Limited for Type testing of Xyron 1000 kW wind turbine at Richadewda Ratlam District, Madhya Pradesh. The measurement process is in progress.
- The final test reports issued to the customer and the project has been closed for the project Type Testing of GVSL 1700 kW wind turbine at Kampaneari Pudhukudi Village, Tenkasi Taluka, Tirunelveli District, Tamil Nadu of M/s. Garuda Vaayu Shakti Limited.
- The measurements at the site are in progress for the project Type Testing of Inox 2000 kW wind turbine at Kidi village, Babra Taluk, Amreli District, Gujarat of M/s. Inox Wind Limited.
- The measurements are in progress for the project Power Curve Measurement of REGEN 1500 kW wind turbine at Vagarai Village, Dindigul District, Tamil Nadu near Dharapuram of M/s. ReGen Powertech Pvt. Limited.

Standards and Certification

- 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 47m Rotor diameter' wind turbine model as per TAPS-2000 (amended). Carried out review / verification of various documentation in connection with renewal of Certificate of 'V 39-500 kW with 47m Rotor diameter' wind turbine model. Based on the review / verification, renewed Certificate has been issued to M/s. RRB Energy Limited.

Issuing renewed Certificate to M/s. RRB Energy Limited

- Review / verification of documentation provided by the various wind turbine manufacturers for more than 50 wind turbine models in connection with Revised List of Models and Manufacturers (RLMM) – Addendum-II 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 of two wind turbine manufacturers.
- Organized the RLMM Committee meeting.
- Issued Consolidated RLMM Addendum-II List dated 10.06.2016 to the Main List dated 28.09.2015 to various stakeholders including wind turbine manufacturers, State Electricity Boards, TRANSCOS and State Nodal agencies etc. The Consolidated RLMM Addendum-II List dated 10.06.2016 was also hosted at NIWE website.
- Prepared consolidated list of wind turbine models and manufacturers marketed in India with Type Certificate as on June 2016 and the same was hosted at NIWE website.
- Completed review / verification of documentation of two prototype wind turbine models received from the wind turbine manufacturers in connection with installation of prototype wind turbines in India as per MNRE guidelines.
- Organized a committee meeting on Prototype wind turbine models.
- A letter has been issued in connection with grid synchronization of one prototype wind turbine of “SUZLON S111 DFIG 2.1 MW, 50Hz-HT” model of M/s. Suzlon Energy Limited to the concerned State Nodal Agency, as decided by the Prototype Committee.
- A letter has been issued in connection with grid synchronization of one prototype wind turbine of “VENSYS 115” model of M/s. ReGen Powertech Private Limited to the concerned State Electricity Board, as decided by the Prototype Committee.
- Carried out the inspection for the Manufacturing Evaluation at Assembly Unit of M/s. Regen Powertech Private Limited at TADA - Mandal, Nellore District, Andhra Pradesh along with M/s. TUV Rheinland in

connection with Type Certification of 'VENSYS 115' wind turbine model.

- Carried out the inspection for the production unit of wind turbine tower for M/s. ReGen Powertech Private Limited at M/s. Toolfab Engineering Industries Private Limited, Trichy, Tamil Nadu along with M/s. TUV Rheinland in connection with Type Certification of 'VENSYS 115' wind turbine model.
- Carried out the inspection for production unit of the converter at M/s. Delta Power Solutions Private Limited at Rudrapur, Uttaranchal along with M/s. TUV Rheinland.
- Co-ordination works with Bureau of Indian Standards (BIS) and members of working group on standards in connection with preparation of draft Indian standards & review of draft IEC documents on wind turbines are ongoing.
- Based on the review of a draft IEC standard, jointly with working group members, voting recommendation has been prepared and sent to BIS for further forwarding to IEC TC 88
- S&C unit is providing technical support to CMD of BIS on IECRE activities. Based on review of a draft proposal of IECRE sent by BIS, voting recommendation has been prepared and sent to BIS for further forwarding to IECRE.
- Based on the request received and documentation submitted, wind turbine Type Certification services of M/s. WindGuard Certification GmbH is recognized by NIWE.
- Process of renewal of certificate of Pawan Shakthi – 600 kW wind turbine model is being initiated.
- Co-ordination with wind turbine manufacturers in connection with documentation to be submitted as per MNRE guidelines on prototype wind turbine models after issue of letter in connection with grid synchronization of prototype wind turbines are ongoing.
- The continual improvement and maintaining the quality management system are ongoing.

Wind Turbine Research Station

The complete Operation and Maintenance works of various nature for the 9 nos 200 kW MICON Wind Electric Generators and of 9 nos 400 V / 11 kV Transformers including transmission lines of the WEG's were successfully completed in all aspects and all the machines are being kept ready for the uninterrupted operation during the windy season 2016 which is expected to start from first week of June 2016.

Installation works of Micro Thruster Augumented at 200 kW MICON at WTRS, Kayathar by VIT, Vellore in respect of erection of cyclinders, compressor in the control room at site were completed and connecting pressurised pipe inside the WEG and through the low speed shaft alongwith mechanical seal is under progress.

Visitor:

Dr. Aswin Kumar, Managing Director, Solar Energy Corporation of India, New Delhi alongwith Director (Solar), SECI, New Delhi visited the WTRS, research facilities on 9th June 2016.

Visit of Managing Director, Solar Energy Corporation India, New Delhi to WTRS, Kayathar

Information, Training and Customized Services

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

NATIONAL TRAINING COURSE

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

INTERNATIONAL TRAINING COURSE

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

Apart from the above confirmed training courses, the following proposals have been submitted to MNRE / MEA and self financed training courses;

International training courses for

1. ASEAN Countries
2. ISA Countries
3. African Countries – under AIFS – III
4. SAARC countries
5. Specialized Tailored course for Ministry officials of Ministry of Energy and Mineral Development, Kampala, Uganda
6. Customized training course for Energy faculties of Hydro Power and Renewable Energy department of Water Resources University, Vietnam.

National training courses for

- Capacity Building Training Programme on Design, Fabrication & Maintenance of Small Wind Turbine.
- Special Training course for the following companies
  1. M/s. Tech Mahindra Limited.
  2. M/s. Siemens Technology Services Private Limited (STSPL).
  3. M/s. National Hydro Power Corporation Limited (NHPC).
  4. M/s. Vestas Wind Technology Pvt. Limited.

Students Internship

The following foreign students training fellowship applications have been processed under different scheme who will be doing research work at NIWE for a period of 6 months.

Research Training Fellowship for Developing Country Scientists (RTF-DCS)

1. Mr. Tchodou Samah B from Charge of Electrification and Power Equipment, Directorate General of Energy / Ministry of Mines and Energy, Lome Togo
2. Mr. Aung Ko Oo from Renewable Energy Research Department, Department of Research and Innovation, Ministry of Education, Myanmar.
3. Mr. Daniel Menga from Department of Renewable Energy University of Maroua, Cameroon.
4. Mr. Tinotenda Zvavashe from National University of Science & Technology, Zimbabwe.
5. Mr. Tchawe Tchawe Moukam from University of Ngaoundere, Cameroon
6. Mr. Edouard Mboumboue from Cameroon

Indian Science and Research Fellowship (ISRF)

1. Dr. Thi Thi Soe from Renewable Energy Research Department, Department of Research and Innovation, Ministry of Education, Myanmar.

GLOBAL WIND DAY CELEBRATION

Global Wind Day is a worldwide event that is commemorated annually on 15 June and NIWE has been celebrating the Day since 2009 with various events among school students and teachers. This year, the Global Wind Day events were organised at two locations in Tamil Nadu i.e., Chennai and Vedaranyam, Nagapattinam in association with WWF-India. The event includes the capacity building training workshops for teachers and competitions for students.

CELEBRATION AT CHENNAI

This year Global Wind Day celebrations has events on 14th and 15th June 2016 various competitions for students separately at the NIWE campus.

On 14th June 2016, the celebrations began with inauguration function wherein Dr. P. Kanagavel, Additional Director and Head ITCS, NIWE welcomed the gathering and Dr. S. Gomathinayagam, Director General, NIWE inaugurated with insightful address. In the address, he pointed out the importance of renewable energy resources especially wind energy in combating the primary contributors to the phenomena of climate change. He reiterated that those of us who are living on this planet should constantly remind ourselves of the fact that we have borrowed this Earth from the future generations and therefore must strive to contribute meaningfully towards the collective efforts to mitigate the consequences of use of fossil fuels. Col. Sanath Gopinath, Head, WWF – India, Tamil Nadu Office, spoke of the joint initiative and WWF's activities in India and their role in conservation, education, outreach and policy. Mr. Thangaraj, Coordinator, National Green Corps and Mr. Rajasekar, Coordinator, Eco Clubs were present at the inaugural session. A total of 61 teachers from 55 schools attended the training workshop at NIWE campus.

Capacity Building Workshop on Climate Change And Renewable Energy

After the Inaugural session, the capacity building workshop on Renewable Energy for teachers was conducted wherein Dr. P. Kanagavel made presentation on Climate Change and Renewable Energy. He specified the impact of climate change in the energy sectors and addressed the need for changes in the utilization of energy resources and its generation for daily consumption. He also invited the attention of the participants to the availability of renewable energy resources in India and drew a comparison in its effective exploitation all over the world. Mr. Joel Franklin Asaria, Additional Director, ITCS, NIWE made presentation in the second session on Wind Turbine Technology and status explaining Wind Turbine technologies and its applications starting from its evoluation and its contribution in Climate Change / Global Warming mitigation.

The teachers who had participated in the workshop were taken to a campus tour wherein NIWE Renewable Energy facilities were showcased Briefing and demonstrations pertaining to the work being carried out at the NIWE.

Competitions for Students on Renewable Energy

On 15th June 2015 the Global Wind Day celebration started with students being addressed by Dr. S. Gomathinayagam, Director General, NIWE advising the students not to be inhibited by their age and inexperience and invited them to explore all possibilities to make a difference in their environment. Col. Sanath Gopinath, Head WWF- India Tamil Nadu Office invited the students to seek effective solutions to environmental problems instead of fixating on the quest for perfect solutions. Dr. P. Kanagavel, Additional Director and Head ITCS, NIWE explained the significance of the Global Wind. Thereafter, Mr. S. Saravanan proceeded to conduct the competions for the Students. The Painting and Poster making competitions, along with the Quiz competition were conducted concurrently at three different areas of the venue.

After the competitions were concluded, the students were taken on a conducted tour of the NIWE Renewable Energy facilities during which they were introduced to various interesting aspects of the work being carried out at the institute.

Glimpses of Global Wind Celebration at Chennai

Dr. S. Gomathinaygam, Director General, NIWE gave away prizes to the winners of the competitions and released two Posters highlighting the significance of Renewable Energy sources.

CELEBRATION AT VEDARANYAM

This year NIWE and the WWF-India extended the Global Wind Day programme beyond Chennai to Vedaranyam Taluk, Nagapattinam district. The programmes were organized and conducted on similar lines as was done at Chennai. The events were jointly coordinated by Mr. G. Singaravelu, Coordinator, Phonix, WWF Nature Club, Anantharasu Aided Middle School and Mr.S. Karunanithi, Head Master, R. N. Government Higher Secondary School,Aayakaranpulam II.

On 25th June 2016, painting competition for students on renewable energy resources was conducted at Aayakaranpulam II. A total of 41 students from classes 7th & 8th participated in the drawing competition. On 27th June 2016, a capacity building training workshop was conducted for the teachers of higher secondary schools in and around Vedaranyam and Thiruvarur. The workshop began with the inaugural session led by Mr. S. Karunanithi, Headmaster of host school. The District Science AEO's Mr. M. Balasubramanian from Nagapattinam and Mr. Victor Raj from Thiruvarur shared their knowledge with the teachers and emphasized the important of this workshop. Mr. Singaravelu, Coordinator, Phonix WWF Nature Club and Mr. Muthamizh Anandan, Coordinator, National Green Corps also addressed the teachers. A total of 41 teachers from Nagapattinam and Thiruvarur districts participated in the workshop. Dr. P. Kanagavel and Mr. Joel Franklin Asaria made presentations similar to the Chennai celebration.

Glimpses of Global Wind Celebration at Vedaranyam

Students Visit

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

- 14 students & 1 staff from National Productivity Council, Training Programme on "Management and Technical Aspects of Energy Audit & Efficiency in Generation Sector" for Nepal Electricity Authority, Katmandu, Nepal on 29th April 2016.

Visitors

- 14 Nepal Delegates from Electricity Authority, Govt of Nepal and 2 NPC India coordinators visited NIWE on 29th April 2016. Mr. M. Joel Franklin Asaria, Additional Director, ITCS, NIWE has made a presentation on "Wind Energy Technology and its Applications" along with NIWE's activities & services after the welcome and brief information about NIWE by Dr. P. Kanagavel, Additional Director & Head, ITCS, NIWE and the campus facilities were also showcased.

Engineering Services Division

- **Video conferencing :** The Audio – Video conferencing facilities has been inaugurated on 16th April 2016 at WTRS Kayathar Campus.

NIWE Official Face-book page creation

- **NIWE Official Face-book page creation :** NIWE Face book page has been created to manage social activities of NIWE. (www.Facebook.com/niwechennai)
- **Landscaping work at NIWE name board :** In the front side of the NIWE campus, landscaping work of the NIWE name board work has been carried out in this quarter.
- **Civil General Maintenance Works :** Construction of Store room and Staff room at the rear side of the utility Block work has been completed and inaugurated during the month of May 2016.
  i) Construction of Security Guard room near entrance main gate electrical work is under progress.
  ii) Construction of flooring and fixing of tiles work at WRA cabin approval has been received and the work is under progress.

iii) Construction of front side sump platform and dismantling of parapet wall work approval has been received and the work is under progress.

iv) Construction of flooring and fixing of tiles work at Driver Cabin approval has been received and the work is under progress.

v) Replacement of damaged tiles work around the conference hall has been completed in May 2016.

- **2.5 kW Wind Solar Hybrid System:** A new 2.5 kW Solar Hybrid System has been installed during June 2016 on roof top of NIWE building for study purpose.

2.5 kW Wind Solar Hybrid System

Solar Radiation Resource Assessment

- Quality Controlled data of 21 SRRA stations were supplied under SDSAP policy.
- Calibration of 7 pyranometers and 1 pyrheliometers were carried out.
- Karaikudi SRRA station relocated on 2nd May 2016 in the same campus from ground level to rooftop.
- SRRA submitted Project proposal for DPR preparation at 4 locations in Maharashtra to MEDA.
- Relocated PDPU, Gandhi Nagar SRRA/AMS station at Gandhi Nagar.
- Final report on 4 MEDA stations for the period April 2015-March 2016 and 2 MEDA stations for the period from January to December 2015 were submitted to MEDA, Pune.
- Project proposal on extension of the 2 stations as well as 4 stations submitted to MEDA, Pune on 21st & 29th April 2016 respectively.
- A committee meeting to fix the Term of Reference on EOI on Solar Forecasting held on 30th April 2016.
- 3 days training and workshop organized by SRRA in association with M/s. Digicollect, Bangalore on "Open Source Quantum GIS, Mobile Based Data Collection and Web GIS Application" during 30th May to 1st June 2016.
- SRRA officials visited IMD,Pune for Intercomparison studies of our primary sensors against IMD's primary sensors in Pune during the period 26th March to 3rd April 2016.
- Dr. G. Giridhar visited Leh during 9th to 11th May 2016 for feasibility study on Solar Potential at Defense Institute of High Attitude Research (DIHAR) at Leh and submitted a report to DIHAR.
- R. Sasikumar and one Project Assistant visited NRSC, Hyderabad for discussion on 26th May 2016.

Visitor

Dr. Mali, DDGM (SI), IMD, Pune and Dr. R.D. Vashishtha, Former DDGM, IMD, visited Chennai, PEC, Thiruvallur and Pondicherry SRRA stations during 5th to 7th April 2016.

Knowledge Sharing and Management

World has become one small village made true by the developments in media that brings Information and Knowledge to our doorsteps through its advances. NIWE strives to provide the last mile connectivity within NIWE for its Technologists, Engineers and their support staff.

Dredging up the relevant science & technology nuggets for its staff through the TTT platform has always been fun. Making it more self-sustained is the freshness brought in week-on-week by the new speakers, who troll the science pool to bring the best to the fore.

KS&M walks the extra mile in grooming new human resource for the field by handholding students of science & technology doing their UG, PG or Research scholarship in new domains of wind, which comes out as their internship report, thesis paper or value addition to their research. In this quarter more than 15 students have undergone internship in NIWE and many more will be joining in the near future.

Our open workgroup with its loaded platforms of latest software has become the cynosure of NIWE staff, who spend hours together using the facility to hone their soft skills. Many beneficiaries have since moved on to industry taking with them the values build on this platform.

In-line with the societal mission of NIWE, one more initiatives is in the pipeline to support the human skill development of NIWE staff and will be known in the next quarter update of the unit's work.

Technology Think Tank

TTT is a modern critique of ancient Athenian Ecclesia, an open platform for ideation and cerebration within NIWE. As on date 75 such sessions have been organised by NIWE. The following technical presentations were made and discussed in this platform during the reported quarter:

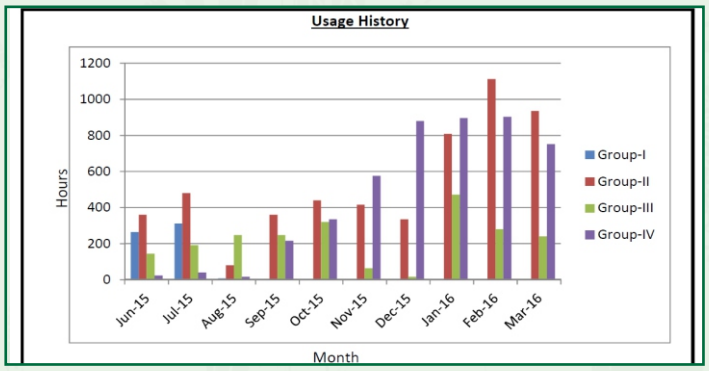
Technology Think Tank (TTT) lecture in progress

Date	Sharing Unit	Topic of the Presentation
07-04-16	ESD	Cyber Threats and Trends
21-04-16	ITCS	Solar Flat Plate Collector & Thermal Energy Storage System
28-04-16	SRRA	Dye Sensitized Solar Cell
12-05-16	KS & M	An Overview of Energy Challenges and Storage Systems

Date	Sharing Unit	Topic of the Presentation
19-05-16	WRA	Overview of Global Wind Pattern and Indian Monsoon
26-05-16	OSWH & IB	Renewable Hybrid System
02-06-16	S & C	Renewable Energy in India : Status and Potential
09-06-16	KS & M	Power Electronics Technology for the next generation Wind Turbine System

Work Group Usage

The work group facility opened for the use of engineers and students to hone their skills in various latest renewable software has found a very large patronage from both within and outside NIWE. The patronage for various software groups are shown below:



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

Usage History

Internship & Projects for Students

About 15 UG students and 5 PG students have completed their final year project at NIWE and 16 students have completed their summer internship at the unit. A few more students are expected to join the program in the coming Quarter for their internship.

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

Dr. S. Gomathinayagam, Director General

- Attended the Standing Committee Meeting on Energy "Examination of the Demands for Grants of MNRE" on 4th April 2016.
- Delivered a talk on "Offshore Wind Power : Status of development in India" in 'Indo-Australian Marine Renewable Energy Workshop' at IIT Madras on 5th April 2016.
- Chief Guest for the Inaugural function of International Conclave on RE Systems and Technology (ICREST-16) and delivered an Inaugural Address on "Scenario and trends of Renewable Energy Systems" at Saveetha School of Engineering, Chennai on 6th April 2016.
- Attended Meeting of the Committee to review MNRE guidelines for Installation of Prototype Wind Turbine Models in MNRE, New Delhi on 7th April 2016.
- Visited Kayathar to explore additional lands at Tuticorin/Kayathar and at nearby places for expansion of NIWE activities on 15th & 16th April 2016..
- Attended Combined Press Conference of Ministry of Power, Coal & MNRE and issue of Appreciation Letters at Delhi on 4th May 2016.
- Chaired R&D Meeting (Dept of Physics, School of Mechanical & Construction Engineering) of Vel Tech Dr. RR & Dr. SR Technical University, Chennai on 8th May 2016.
- Attended Meeting on "CEA notification on the connectivity to the Grid (LVRT)" at NIWE, Chennai on 12th May 2016.
- Attended "All India Official Language Conference and Brainstorming Camp" at Munnar during 1st to 3rd June 2016.
- Discussion held with DG, MEDA regarding conducting of oneday workshop on "Small Wind Energy and Hybrid Systems & its relevance to Telecom Sector" at Pune on 6th & 7th June 2016.
- Attended the Revised List of Models & Manufacturers Meeting (RLMM) at NIWE on 8th June 2016.
- Participated in the "Hands on Sand," event organized by VESTAS at Marina Beach, Chennai on 15th June 2016 and delivered special address at Vestas Office.
- Attended the Second Meeting of the National Lab Policy on Renewable Energy Sector at MNRE, Delhi on 22nd June 2016.
- Attended the Briefing Meeting of the Standing Committee on Energy at MNRE, Delhi on 23rd June 2016.
- Chaired the Evaluation Committee Meeting for recommending the R & D proposals in thrust areas of small wind energy and hybrid systems for 2016-17 held at NIWE, Chennai on 25th June 2016.
- Attended the Meeting of Study-visit of the Committee on Papers Laid on the Table, Rajya Sabha at Kodaikanal on 27th & 28th June 2016.
- Attended Operation Review Meeting of NIWE at MNRE, Delhi on 29th June 2016.
- Attended the 26th GC Meeting of SSS-NIBE at MNRE, New Delhi on 29th June 2016.

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

- Delivered a lecture "Deployment of Small Wind Turbines on Telecom Tower - A Case Study", SWES Training Programme.
- Attended the Meeting of the Technical Committee as a Technical Member, "to review the technicality and recommend the modalities of allowing type tested grid tied small wind turbines for off-grid/battery charging applications under SWES scheme" at MNRE, New Delhi on 14th June 2016.
- Attended the first meeting of Evaluation Committee to review, scrutinize and recommend the 55 nos. of R&D project proposals received by the Ministry convened under the chairmanship of Director General, NIWE at NIWE, Chennai on 25th June 2016.

K. Boopathi, Additional Director & Head, WRA

- Attended meeting on the captioned Line of Credit project in the Chamber of Mrs.Mukta Shekhar, Director/DPA-I & Spl. Projects, Ministry of External Affairs, New Delhi on 22nd April 2016.
- Delivered a Wind Power Forecasting presentation during joint meeting of various stake holders of Wind Power investors at Jaipur State Load Despatch Centre, Jaipur on 13th May 2016.
- Attended meeting/discussion with TANGEDCO officials in connection with Wind Power Forecasting services on 1st June 2016.
- Participated as a Speaker during Capacity Building program on the Integration of Renewable Energy Resources (RES) into the Grid for the Power Utilities operating in Northern Region organized by M/s.Mercados Energy Market at New Delhi on 14th June 2016.

A. Haribhaskaran, Deputy Director (Technical), WRA

- Attended meeting on implementation of 200 nos. of 50m WMS in NE regions and establishment activities at MNRE on 26th & 27th April 2016.

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

- Attended second LVRT meeting on compliance of honorable CERC order and other provisions of CEA/CERC regulations at SRPC, Bangalore on 18th April 2016.
- Participated in the meeting on training / education / capacity building at Green Energy Corridors, New Delhi during 23rd & 24th May 2016.
- Attended meeting/discussion with TANGEDCO officials in connection with Wind Power Forecasting services on 1st June 2016.

J. Bastin, Assistant Director (Technical), WRA

- Attended Kickoff meeting in connection with Bird migration study at KREDL, Bangalore on 6th April 2016.

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

- Attended the committee meeting on review of MNRE Guidelines for installation of Prototype Wind Turbines Models held at MNRE, New Delhi.

S. Arulselvan, Assistant Engineer, S&C

Participated in the second meeting for compliance of orders of Hon'ble CERC regarding LVRT and other provisions of CEA/CERC regulations, conducted by SRPC at Bangalore.

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

- Delivered a lecture on "Indian wind energy development and scenario" in the International Conclave on Renewable Energy Systems and Technology-ICREST-2016 organized by Saveetha School of Engineering, Chennai on 7th April 2016.
- Delivered lectures on "Green Library & Energy Efficiency in Libraries" in the Refresher Course in Library and Information Science scheduled during 20th May to 9th June 2016 at UGC-Human Resource Development Centre, Bharathidasan University, Trichy on 30th May 2016.
- Delivered a lecture on "Climate Change Impacts and Renewable Energy" Organized by WWF- India Tamil Nadu State Office at NIWE, Chennai on 15th June 2016.
- Delivered a lecture on "Climate Change Impacts and Renewable Energy" organized by WWF- India Tamil Nadu State Office at R Nadesanar Govt. High School, Vedaranyam on 27th June 2016.

M.Joel Franklin Asaria, Additional Director, ITCS

Delivered a lecture on "Wind Energy - An Comprehensive Overview" organized by WWF- India Tamil Nadu State Office at R Nadesanar Govt. High School, Vedaranyam on 27th June 2016.

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

- Delivered a lecture on "Advances in Humanities, Physical & Mathematical Sciences" at S.A. Engineering College on 6th April 2016.
- Attended meeting with MNRE, SECI and NISE officials at New Delhi during 25th to 28th April 2016.

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

- Delivered a lecture on "Role of Solar Resource Assessment in Solar Power Technology" in International conclave on Renewable Energy Systems and Technology (ICREST) - 2016 at Saveetha School of Engineering, Saveetha University, Chennai on 8th April 2016.
- Delivered a lecture on Quality Assessment SRRA data in the Skill Development Program on solar resource assessment and calibration at NISE, Guragon on 5th & 6th May 2016.

Visits Abroad

K. Boopathi, Additional Director & Head, WRA & **B. Krishnan,** Assistant Engineer, WRA has carried out site visit in South & Central Vietnam for ground reality verification for 38 MW & 30 MW wind farm from 3rd to 7th April 2016.

A. Senthil Kumar, Director & Head, S&C & **S. Arulselvan,** Assistant Engineer, S&C participated in the meeting of Certification Body – Wind Turbines and other meetings during 21st to 24th June 2016 at M/s. TUV Rheinland Industrie Service GmbH, Cologne, Germany.

Participation in Meeting of Certification Body – Wind Turbines at TUV Rheinland, Germany

Karthik. R attended the 14th BSRN Science Review workshop organized by WMO during 26th to 29th April 2016, at Canberra, Australia and proposed 4 stations to bring under BSRN network. Also delivered a talk on "4 proposed stations & on Indian experiences of Solar Resource Assessment". BSRN accepted to incorporate 4 stations under their prestigious world network.

Publications

Case Study on Leading India to Global Energy League is published in the Inclusion Magazine Vol.7, Issue 1, January – March 2016, p.55.

Dr. S. Gomathinayagam, Electricity Grid and LVRT compliant Wind turbines, Windpro Magazine, Vol. 4, Issue 6, June 2016, p 22.

Awards

CITATION AND SHIELD

Citation and shield received for NIWE from Parivarthan Jan Kalyan Samiti during All Indian Raj Bhasha Conference and Workshop 2016 held at Kovalam, Trivandrum inaugurated by Hon'ble Dr. Prasanna Kumar Patsaani, Member of Parliament, Lok Sabha & Coordinator, Parliamentary 2nd Sub Committee on Official Language towards implementation of Official Language Hindi in Government Office held during 26th-28th May, 2016.

Citation and shield received for NIWE from "All India Official Language Conference & Brainstorming Camp" being organised in Munnar (Kerala) by "Rajbhasha Seva Sansthan", inaugurated by Hon'ble Dr. A. Sampath, Member of Parliament, Lok Sabha and Member-"Committee of Parliament on Official Language", towards implementation of Official Language Hindi in Government Office held during 1st - 3rd June 2016.

EDUCATION LEADERSHIP AWARD

NIWE has been awarded **"Education Leadership Award"** in the ABP News National Education Awards held on 23rd June 2016 in the World Education Congress at Mumbai in recognition of leadership, development, marketing an institute and industry interface of an Educational Institute.

PREPARATION OF WIND SPEED MAP OF INDIA at 20m A.G.L.

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Background

Small Wind is one of the potential sectors in India to achieve government's ambitious goal of "Power to All" through eco-friendly, distributed power. The small wind systems can play very significant role in Indian energy mix, in one hand they can help to electrify the rural areas, agricultural pumps, etc., on the other hand they can be vital to reduce the electrical load in urban environment.

The small wind turbine (SWT) market has been on the upswing from last three to four years. The main drivers to this growth are demand-supply gap in energy, increased prices of the fossil fuels, improved small wind turbine technology and the diverse application to which this can be used both for grid-tied and standalone battery chargeable systems. The market for SWT technology is encouraging in India also and may require favourable policies, adoption of micro-generation technologies, reduced cost etc., to reach a significant level.

In order to promote small wind / hybrid technology under off-grid mode throughout the country, Ministry is implementing a scheme for programme on "Small Wind Energy and Hybrid Systems". As per the aforesaid scheme, one of the essential criteria stipulated by the Ministry for sanctioning the SWES projects is " the site for installation of originators should, preferably, have an annual average wind speed of about 15 kmph (4.17 m/s) or above at 20m height. The wind speed ata particular site has to be obtained from NIWE (erstwhile C-WET) or any other agency using actual wind data collected by NIWE or by using standard software programme like Wind Atlas etc.,"Hence, in the absence of representative actual measurements, meso-scale model outputs derived from Indian Wind Atlas are relied upon in quantifying the wind speed of an area to become eligible for the scheme.

In recent times, the potential mapping and wind flow modeling techniques have improved in a tremendous way with increasing accuracy, compare to the previous times. In addition, the number of actual measurements for validation of the meso-scale results has also been increased during the course of time.

NIWE has utilized these advancements, in the recently published "Indian Wind Potential Map at 100m agl" and estimated the indicative wind potential of the country as 302 GW at 100m agl. The map has been prepared using meso-micro coupled WRF (Weather Research Forecasting) modeling and at a very high resolution of 500m covering the entire country including its islands. At present, for the betterment of the small wind sector, as directed by the ministry, NIWE intends to map the wind speed at 20m height using the same modeling methodology.

Atmospheric Modeling

High-resolution numerical modeling of weather conditions provides sensitive information of unprecedented quality, crucial for the development of any wind project, from the early stages of prospecting through wind farm design to long-term adjustments. In particular, the use of meso and micro-scale coupled wind resource products has gained widespread acceptance by the wind industry community, offering reliable reference data for wind condition characterization and long-term data solutions. In this work, meso to micro-scale coupling is solved within modelling chain by the most natural and smooth approach - seamless simulations of WRF down to 500m resolution.

The core of the technical modeling approach for this work is the atmospheric model Weather Research and Forecasting System (WRF) developed by NCEP/NCAR (National Centre for Environmental Prediction / National Centre for Atmospheric Research). The WRF-system is a community-based, open-source model, where the latest advances in physics and numeric are incorporated in a modular way. The WRF model has been employed largely for research and operational weather forecasting and climate analysis. It represents a cutting-edge modeling technology. As well as optimized dynamic and physical cores, it includes a nest domain, allowing zooming atmospheric circulation down to near wind-farm resolution.

WRF model has a long record on usage and it is employed operational in many weather services, cutting-the-edge research activities and different industry applications. WRF development has engaged a wide community of users which meant large peer-review validations analysis and upgrading of advances in the different components of the weather & climate modeling science.

WRF model is now the first generation of multi-scale chain modeling that can seamlessly go from regional to wind farm scales. Regarding, micro-scale backed, WRF incorporates innovation planetary boundary layer sub model (PBL) that can handle effectively turbulence and flow adjustments due to high resolution orographic effects. Moreover, WRF is a unique solution to provide dynamic representation of wind flow at wind farm resolution including mechanical and thermal turbulence.WRF model includes a set of sub-models to treat dynamically and physically flow regime at very high resolution. These modules employ non-linear representations of different topography induced mechanisms.

Model Run

The model has been driven by large-scale conditions prescribed by the latest generation of re-analysis projects for the satellite period: NCEP CFS/CFSR (Climate Forecast System Reanalysis). Re-gridded versions of SRTM (no-void) altimetry data will be employed to prescribe altimetry conditions. The ESA Globcover (300m) land use database was employed to characterize land-use classes. Seasonal variation data from ESA Globcover has been included to better prescribe albedo effects during winter periods. In this work, WRF (Weather & Research Forecast) model is used to downscale Reanalysis datasets to the final 500m x 500m resolution. In this downscaling process, several nested domains from coarser to finer resolution grids are used, starting at 27 Km and ending at 500m. Nesting is performed at 27 Km, 3 Km, 1 Km and 500m, each resolution adequate for different scales and characteristic phenomena included in the WRF model. Thus, the WRF model provides output variables at each of the 500m x 500m grid points and therefore no interpolation methods are applied for generating the final results. Each of the grid points is directly written to the final files avoiding any error or

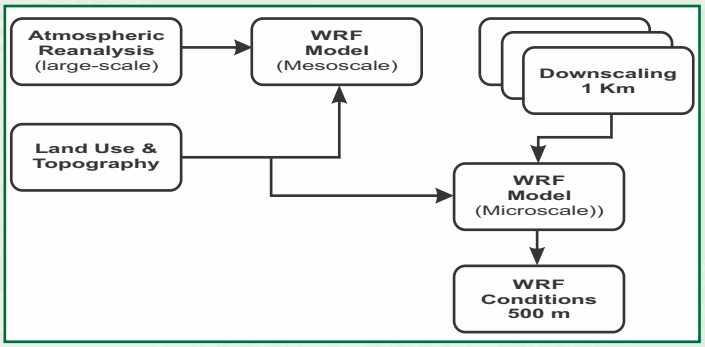

Figure 1: Atmospheric Modelling Flow Chart

truncation issues deriving from interpolation techniques. The modelling flow chart is shown in figure 1.

Wind Speed Map at 20m agl

The wind speed map prepared based on meso-micro coupled modelling methodology is shown in figure 2.

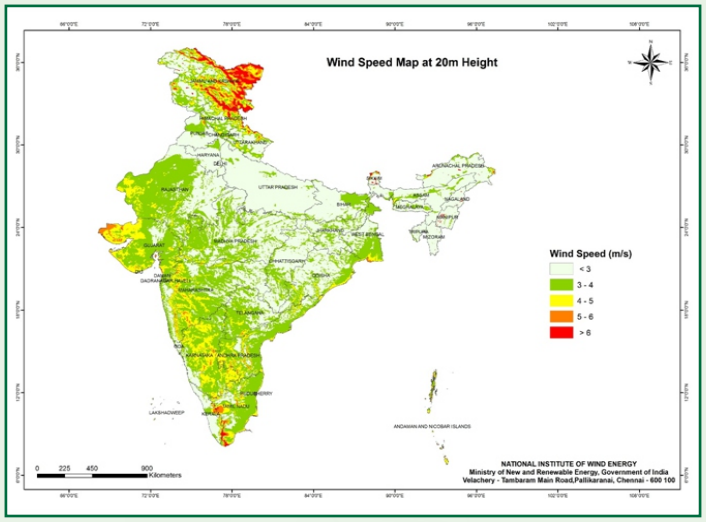

Figure 2: Wind Speed Map of India at 20m agl

Validation

Validation with actual measurements is essential in any model based mapping. Globally, wind potential maps are being prepared using the numerical downscaling techniques from atmospheric models. In general, the following three inputs are used for downscaling & mapping.

- Assimilated Re-analysis data sets – which are gridded data, created through assimilating data collected from various sources at various time scale
- Generalized Elevation data
- Generalized Land use Land cover data

Due to the nature of inputs and methodology of prediction, the results generated using atmospheric models should always be interpreted with caution. These results can be used to provide indication about large scale variations of wind. However due to the accuracy level of inputs & uncertainties in the downscaling techniques, the modeled results may not predict localized wind variations accurately. This issue cannot be fully resolved, but the error level of the modeled map can be quantified with the help of actual measurements, which in turn help to handle the map results effectively. In this study, NIWE has utilized 752 physical measurements to validate the map result. The wind speed at 20m has been estimated through measurement or derived with the help of power law index. Based on the validation study, the mean absolute percentage error of the map is found to be 17%. The state wise / region wise validation results are shown in table. It is always advisable to handle the map results with the error percentage into consideration

Table: State-wise / Region-wise Validation Results

State / Region	No. of Masts	MAE	MAPE	RMSE
Andaman & Nicobar Islands	19	1.20	0.4	31.38
Andhra Pradesh	71	0.90	0.17	1.15
Bihar	3	0.34	0.13	0.34
Chhattisgarh	7	0.44	0.14	0.60
Goa	4	0.34	0.11	0.47
Gujarat	81	0.74	0.15	0.91
Haryana	6	0.63	0.19	0.80
Jharkhand	3	0.19	0.05	0.22
Karnataka	69	0.76	0.15	1.01
Kerala	29	0.95	0.19	1.24
Lakshadweep	9	0.42	0.08	0.49
Madhya Pradesh	41	0.94	0.21	1.09
Maharashtra	127	0.51	0.11	0.69
Odisha	15	0.65	0.17	0.76
Puducherry	4	0.39	0.10	0.45
Punjab	9	0.29	0.14	0.45
Rajasthan	47	0.69	0.16	0.85
Tamil Nadu	82	0.63	0.14	0.86
Telangana	19	0.70	0.15	0.81
Uttar Pradesh	11	0.51	0.17	0.60
West Bengal	10	0.69	0.19	0.85
North East Region	45	0.73	0.26	0.98
High Complex Terrain (Utterakhand, Jammu & Kashmir, Himachal Pradesh)	41	0.92	0.28	1.16

Conclusion

NIWE has utilized advanced numerical modelling and downscaling techniques in preparation of the 20m wind speed map. The map has successfully validated using 752 physical measurements and mean absolute percentage error has been estimated as 17%. The indicative map is made available in the GIS based web platform at a resolution of 500m for the access of different stakeholders of the industry. However, as stated earlier, since the map is made through numerical modelling, the results should always be utilized with caution.

Acknowledgement

At this juncture, the authors would like to extend their gratitude to the core team of Wind Resource Assessment, NIWE and its project assistants, especially the GIS and IT team for their immense contribution for the successful execution of the work.

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