

EDITORIAL



India has the 4th largest installed capacity in wind power after China, U.S and Germany. The total installed capacity of wind power in India as on March 2018 is around

34 GW.

The fluctuating nature of renewable energy, be it solar or wind, is an issue for any grid in the world.

India's massive power grid system needs balancing to deal with the fluctuating/varying nature of power generated from renewable energy flowing into the system and keep supply in sync with demand, says experts. The concern comes as India pushes for an ambitious renewable target of 175 GW by 2022.

In this regard, predicting the RE generation in crucial and challenging for the grid integration of solar and wind integration. In this regard NIWE under took the issues by establishing the Centre for Excellence in Variable Generation Forecasting (Wind & Solar generation) and has improved the forecasting accuracy widely. NIWE has signed MoU with ISRO SAC Ahmedabad for High Resolution Numerical Model outputs. Further, as part of indigenous process, our team has designed forecasting model for intraday forecasts, which is under the testing process.

The first offshore unit LIDAR in gulf of Khambhat at Gujarat was installed by the WRA&O during November 2017, which fetches the complete wind data. Various information about water depth, sea depth and seabed topography and subbottom profile are obtained from bathymetry information through a survey, which illustrates the understanding of the sea bed

conditions precisely.

Further to substantiate the wind generation information countrywide, an on-line registry with 'Geo-tagging' of each wind turbine was established. As part of the source each wind turbine was given a Unique identification code facilitating the extraction of static and dynamic data inturn providing appropriate thrust action for better forecasting of wind generation.

As part of our commitment to knowledge transfer and capacity building, several invited lectures have been delivered by our officials in both external forum as well as internal course programs.

It is of great pride to state that FOUR of our Solar Radiation Resource Assessment (SRRA) stations have been included in the BSRN Global Network out of nine in Asia. The Baseline Surface Radiation Network (BSRN) is the project under the umbrella of World Climate Research Program (WCRP) aimed at detecting important changes in the Earth's radiation field at the Earth's surface. Radiation measurements are indispensable for climate research as they provide the best check for the theory of radioactive transfer in the Earth's atmosphere and can be used for the evaluation and improvement of models designed for weather and climate prediction. Furthermore, long-term measurements of surface radiation provide an opportunity for the detection of climate change.

NIWE has been awarded the prestigious Shield & Citation for having secured First position for best performance in the progressive use of Official Language during the year 2015-17 in the Committee (TOLIC) meeting held at Chennai.

Dr. K. Balaraman, Director General



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Wind Resource Assessment & Offshore

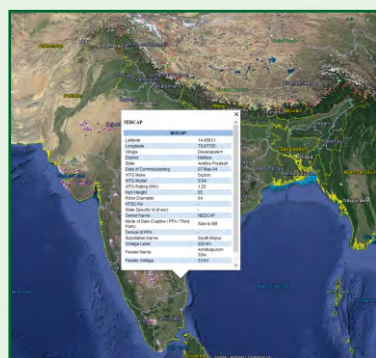
Wind Resource Assessment (Uncovered / New Areas)

During the period three wind monitoring stations have been commissioned in 2 states (1 in Manipur, 2 in Arunachal Pradesh). In addition to this, 11 sites have been commissioned using 11 Airtel Telecom Towers in NE states namely Meghalaya, Mizoram & Tripura. Presently, 69 wind monitoring stations & Telecom towers are operational in 12 States under various wind monitoring projects funded by the Ministry of New and Renewable energy (MNRE) as well as various entrepreneurs.

Consultancy Projects

The following consultancy projects have been completed and reports have been submitted for promotion of onshore wind farm development in the country.

- Verification of Procedure of wind monitoring for 4 sites.
- Micrositing and Energy Estimation for 1 site.
- Energy Yield Assessment for 3 sites.
- Validation of Energy Yield Assessment for 1 site.



Wind turbine static information on geo-spatial platform

Geo-Tagging of Wind Turbines Installed Across the Country

NIWE is creating a centralised database of existing and proposed installations in the country. NIWE has initiated data collection from SNAs and other Stakeholders. As on

date, information of about 15000 MW of wind turbines has been received and the verification process is underway.

The process of development of web portal initiated and the work plan for the same was prepared. Approval was obtained to develop the web portal. Preparation of detailed required specification is underway. On completion, the vendor for web portal development will be identified through tendering.

Expression of Interest of First offshore wind farm in India at Gulf of Khambhat, off Gujarat Coast

The request for 'Expression of interest (EoI) has been uploaded in the NIWE website for development of first

1000MW commercial offshore wind farm in India, off the coast of Gujarat from:

- Global entities having experience of installing wind projects of more than 250MW.
- Indian onshore wind manufacturers/power developers have installed 250MW of onshore wind power projects in India having tie up with global offshore wind turbine OEMs (Original Equipment Manufacturers) or global offshore wind power developers having experience of developing at least 250MW of offshore wind power.

Preliminary studies indicate good potential for offshore wind power both in the southern tip of Indian peninsula and west Coast.

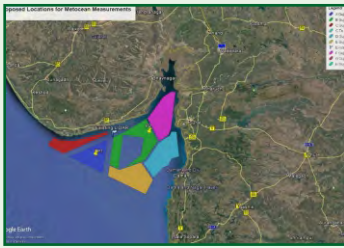
The final selection of developer of the first offshore wind farm will be taken up through competitive bidding among shortlisted parties.

Met-Ocean measurements (Wind, Wave, Tide, Current, Water level, etc) at Gulf of Khambhat and Gulf of Mannar for fostering the growth of offshore wind in the country

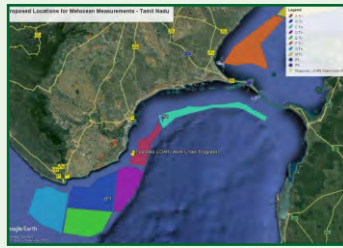
NIWE is in the process of exploring the largest seabed areas off Gujarat and Tamil Nadu coasts with an objective to identify the potential subzones / blocks for promotion of offshore wind farm development in the country. For the purpose, it is proposed to procure 4 LiDARs (2 for Gujarat and 2 for Tamil Nadu) to carry out extensive wind resource assessment. In addition to this, NIWE proposes to carry out the Oceanographic / Hydrographic measurements, which include Water level, Wave Height and period, Current speed and direction and other derived parameters such as Significant Wave Height, Wave period, etc., in and around the wind LiDAR platforms or suitable locations of the Gujarat coast and Tamil Nadu coast to understand the sea-state conditions, which are envisaged as essential and necessary to design the foundation of the Offshore wind turbines. Based on the study, NIWE will plan the installation & other survey activities to understand the Weather Window for Operation and Maintenance planning.

Integrated Wind and Solar Resource Assessment through Mapping and Measurements

Reliable background information on the availability of renewable resource and its geographical variation will play



**Proposed met-ocean locations
in Gulf of Khambhat, Gujarat**

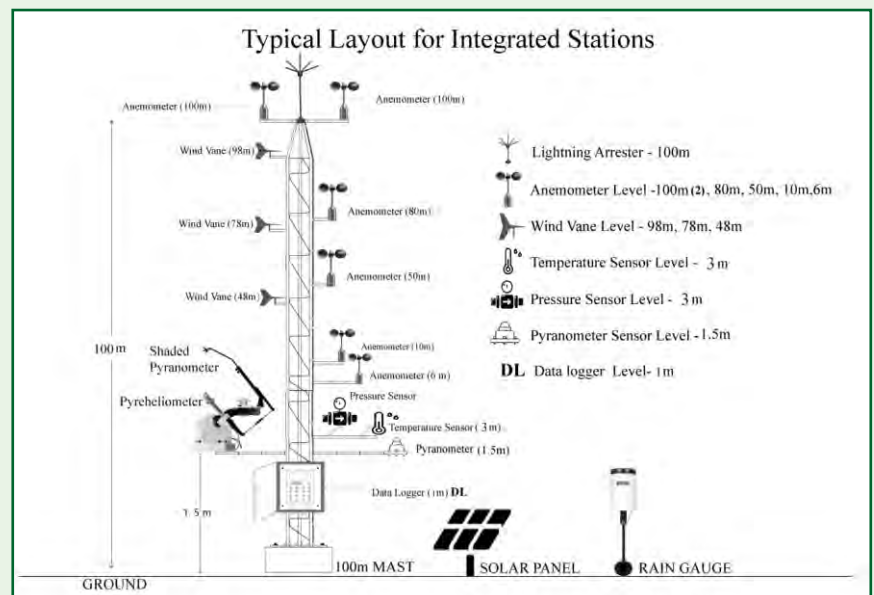


**Proposed met-ocean locations
in Gulf of Mannar, Tamil Nadu**

a major role in achieving the government's ambitious targets. As the wind speed increases with respect to height, the hub height extension is being looked into one of the effective solutions to enhance the energy yield from the wind turbines. With the technical advancements, the modern day turbines have reached the hub height of 120m to 130m and a further enhancement in hub height is foreseen, which would require higher height maps. Studies have also revealed that solar and winds are almost complementary to each other. Hybridization of these two technologies would help in minimizing the variability apart from optimally utilizing the infrastructure including land & transmission system and a Hybrid potential map in this regard would be very much helpful for the stakeholders to identify suitable sites for further investigation. NIWE proposes to prepare indicative Renewable Energy potential maps (wind maps at 120m & 150m and Hybrid

maps) through advanced numerical meso-scale modeling techniques and validate the maps with integrated wind and solar masts and remote sensing in-situ ground measurements to move towards achieving the ambitious goals as envisaged by the government.

Currently the site selection for first 25 Nos., Integrated Met Stations is underway. The team is selecting the location so that it will be useful for multipurpose, viz., Hybrid Wind Solar farm development, Map Validation, Uncovered area exploration, Forecasting, Repowering, etc.,



Typical Layout for Integrated Stations

Testing & Forecasting

LARGE WIND TURBINE TESTING

Type Testing of XYRON 1000 kW wind turbine at Richadewda, Ratlam District, Madhya Pradesh of M/s. XYRON TECHNOLOGIES LTD. The measurements have been completed as per the signed agreement.

Power Curve Measurements of INOX 2000 kW wind turbine with 113 meter rotor diameter at Ranipat Village, Muli Taluk, Surendranagar(Dist), Gujarat of M/s. INOX Wind Ltd. The continuous measurement is on-going.

Power Curve Measurements & Special Measurements for Loads of Pioneer 750 kW wind turbine W49-HH60 a wind turbine with 49 meter rotor diameter at HTSC no. 2988, SF.No. 95/4, 5&6B Part, Poigai Village, Tenkasi Taluk, Tirunelveli District, Tamil Nadu of M/s PARA Enterprises Pvt. Ltd. The measurement is under progress.

FORECASTING

NIWE Indigenous Wind Power forecast model

Tamil Nadu

- As a part of the existing process improvement, created and tested the aggregated power curve model.
- Finalisation of the MoU document with NCMRWF is under progress.
- Coordination carried out with IWPA / TANGEDCO to resolve various issues available in the actual generation of data.
- Carried out changes in the existing data storage architecture & data processing algorithm of TANGEDCO's feederwise generation data to store/process the data faster.

- The GC feeder static data received from TANGEDCO has been processed and feedback has been sent to TANGEDCO.
- IITM NWP Data has been compared with NCMRWF's and ISRO-SAC's NWP data for different terrain condition.
- Various coordination activities carried out with NCMRWF and ISRO-SAC in connection with receipt of NWP data continuously to NIWE.
- Vortex aggregated forecast error analysis from April, 2018 to May, 2018 has been carried out and sent the feedback to Vortex for further improvement.
- Error analysis report has been prepared from March, 2018 to May, 2018 for the State of Tamil Nadu.
- Created an automated logging system to track various activities of NIWE forecasting FTP.
- Initiating Wind Power Forecasting Services to the RE Rich States

Gujarat

- Pilot Operational Wind Power Forecasting services had been initiated for the whole state of Gujarat from April 2018 onwards.
- Established an automated system to collect and process the pooling level actual generation data from Gujarat SLDC.
- Direction Wise error analysis for all the 69 SS for the state of Gujarat has been completed.
- Error analysis report has been carried out from March, 2018 to May, 2018 for the State of Gujarat.

Rajasthan

- Rajasthan SLDC has provided few static data to NIWE and Comments in the static data has been sent to Rajasthan SLDC for obtaining necessary further information. NIWE is in touch with Rajasthan SLDC to obtain the necessary updates in the static data and historical generation data to initialize the Wind Power Forecasting model.

Andhra Pradesh

- MoU, NDA has been signed between NIWE and Andhra Pradesh SLDC on 27th April, 2018 in connection with pilot Wind Power Forecasting project for the entire state of Andhra Pradesh.



- Follow up has been done with AP SLDC to provide necessary static and historical generation data.

Karnataka

- MoU, NDA has been signed between NIWE and Karnataka SLDC on 07th May, 2018 in connection with pilot Wind Power Forecasting project for the entire state of Karnataka.



- Processed the static data received from Karnataka SLDC as per requirement. NIWE is currently carrying out follow up with Karnataka SLDC to obtain necessary Historical/Real time generation data.

Madhya Pradesh & Maharashtra

- Coordination carried out with Madhya Pradesh SLDC and Maharashtra SLDC to finalise the MoU/NDA document.

SMALL WIND TURBINE TESTING

NIWE has undertaken the following

- 1) Type testing of SM2 (1kW) at Wind Turbine Research Station, Kayathar, Tuticorin District, Tamil Nadu of M/s. Windstream Energy Technologies India Pvt.Ltd.
- 2) Type Testing of model Vaata Smart, Vertical Axis WT (5.5 kW) at Wind Turbine Research Station (WTRS), Kayathar of M/s. Vaata Smart Ltd. The measurement is under progress.

Standards and Certification and Research & Development / Scientific & Technical Research

- Completed review / verification of documentations of three 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.
- Subsequent to the committee meeting, the documentation received for one more prototype wind turbine model in connection with installation of prototype wind turbines as per MNRE guidelines is under progress.
- A technical due - diligence project with IREDA is under progress.
- Successfully completed the project on renewal of certificate of V39-500 kW with 47m rotor diameter wind turbine model and obtained approval of Director General, NIWE for issue of renewed Type certificate of V39-500 kW with 47m rotor diameter wind turbine model to M/s. RRB Energy Limited.
- Review / verification of documentation for the project on renewal of certificate of "Pawan Shakthi - 600kW" wind turbine model, has been initiated.
- Review / verification of documentation for the project on revision of certificate of "GWL 225" wind turbine model, has been initiated.
- Organized two days workshop on Risk Assessment / Context Setting on "ISO 9001:2015" on 09th & 10th April 2018 conducted by M/s. DNV GL – Business Assurance India Private Limited at NIWE Chennai.
- Co-ordination with Bureau of Indian Standards (BIS) in connection with standards related works are ongoing.
- The review of the four draft IEC standards sent by Bureau of Indian Standards (BIS) has been completed. Based on the review, voting recommendations for the said draft IEC standards have been prepared and sent to BIS for further forwarding to IEC TC 88.
- The continuous technical supports are being provided to MNRE for their various queries related to Type Certification documentation in connection with Revised List of Models and Manufacturers of wind turbines.
- Quality Management System documents have been prepared for upgradation of QMS as per ISO 9001:2015.
- The continual improvement and maintaining the quality management system are ongoing.
- Carried out various preparatory works in connection with preparation of Indian Wind Turbine Certification Scheme and the same are under progress.



Issuing Renewed Certificate to M/s. RRB Energy Limited



Workshop on ISO 9001:2015

Research and Development / Information Technology / Information, Training and Customized Services

RESEARCH AND DEVELOPMENT

a) Pan India Research Network - "Industry and Academia Amalgamation"

Global Wind Day celebrations of National Institute of Wind Energy (NIWE), Chennai was chosen as the occasion to organize the first one-day workshop of "Pan India Research Network Meeting- Industry and Academia Amalgamation" on 14th June 2018 at NIWE, Chennai.

This meeting is the start of a planned series of interactions between the Indian Academia and Wind power industry to create a conducive ecosystem to facilitate their amalgamation. Deliberations and brainstorming on the Research & Development needs of the Indian wind energy sector is aimed at promoting indigenous research activities that would facilitate the Indian wind industry march to become the global leader in all the facets of the wind energy technology. The 14th June workshop was convened with an express intention to create a hub of synergy that would lead to Industry identified research requirements being taken up for research of national importance through a consortium of Academia and industry, with support from MNRE through NIWE

The Workshop was inaugurated by Shri. S.K. Soonee, Chairman, R&D Council of NIWE & Adviser, Former CEO of POSOCO; Dr. Sanjay Bajpai, Adviser, DST, G.O.I; Dr.K.Balaraman, Director General, NIWE and Dr. S. Gomathinayagam, Industry Expert & Former DG, NIWE by lighting the traditional lamp, with full attendees from the Industry, IWTMA, IWPA, WIPPA and Academia from IIT, NIT & other premier institutions of India.

The first workshop turned out to be grand success, as stated by the Industry & Academia attendees, since it provided the invaluable platform for dialogue and open exchange of views and experiences between the target groups. The workshop focused on some of the major issues that concerns the Indian wind power industry and its immediate requirements for task oriented R&D from academia to Technology Maturity Level (TRL) deliverables. The workshop gave a comprehensive overview of the technical, financial and policy solutions presently available in India and brainstormed for finding solutions to meet the R&D needs of the industry.

The workshop saw attendance in good numbers (more than 100 participants in total) from Indian Wind power sector, academia, research institutions and Indian wind power associations. Industry professionals from M/s. Vestas, M/s. Suzlon, M/s. Siemens-Gamesa, M/s. RRB Energy, M/s. ReGen powertech, M/s. Leitwind Shriram, M/s. Siva Wind Turbine, M/s. Renew Power, M/s. Mytrah Energy, M/s. Enerfra Projects (India), M/s. Siemens (Winergy) etc. attended the workshop and highlighted their R&D needs. Also, the representatives from the major Indian wind power sector associations namely IWTMA, IWPA and WIPPA also attended the workshop and shared their valuable inputs to the forum. From the academia, Professors/ Researchers from premium institutions such as Indian Institute of Science (IISc), IITs, NITs, NAL (National Aeronautical Laboratory, Bangalore) and other premier Universities spread across the Country attended the workshop and the deliberations turned up to be very lively. The workshop saw a lot of erudite discussion between the industry professionals and the academic/ research institutions.

The brief presentation given by the industry representatives and Academic researcher & professors provided the platform for the discussion. Most of the industry representatives were surprised with the amount of research being carried out by various institutions. The Indian wind industry representatives and the academia voiced their enthusiasm to be part of this new initiative taken by NIWE, Chennai and assured their continuous participation to make this endeavour of NIWE a fruitful exercise for the Country and its Make in India Movement.

The following were some of the major decisions taken as the outcome of the workshop

- 1) To convene "PAN – INDIA Research Network meeting" with participation from both industry and academia regularly at different locations
- 2) It is proposed to constitute expertise-wise/ area of interest wise working group among the researchers/ academia to address the problem statements being faced by the industry.
- 3) Academia/ researchers to take up R&D activities with a main focus on technology system development which would facilitate the Indian wind industry to adapt and implement.

- 4) NIWE, Chennai to consolidate all the issues from the industry and list it. Accordingly, academia/ researchers can prepare the project proposal addressing the problem statement and sent it to the concerned industry/ manufacturer to take it forward.
- 5) Indian Wind Energy/ Power associations may think of allocating some funds for carrying out Industry-Academia collaborative projects.
- b.** The unit is entrusted in developing a Smart Micro Grid for NIWE, the proposal was submitted in RC and GC and the same was approved. A considerable budget has been allocated for executing the project and converting the campus into a Net Zero Building.
- c.** Creation of a Small Wind Turbine Hub Facility for Design and Component Testing at the Renewable Demonstration Lab in Wind Turbine Research Station(WTRS), Kayathar, has been approved and International Conference on Small Wind Turbine to be executed in December 2018.
- d.** About 60 UG/PG students have completed their internship at NIWE in the field of Wind and Solar energy mentored by various subject matter experts.

Publications

The unit has contributed to the drafting of the (a) National Energy Storage mission document in the subject of Testing of Energy storage, and (b) Indian Wind Turbine certification scheme. Documents are in draft form needing further redraft and vetting by various stakeholders.

INFORMATION, TRAINING AND CUSTOMIZED SERVICES

Training Courses

NIWE has scheduled the following International Training Courses during the calendar year 2018-19 and the necessary preparation works are on for the successful conduct of the courses.

Upcoming International training courses

S.No.	Description	From	To	Duration
1.	22 nd International Training Course on Wind Turbine Technology and Applications	18.07.2018	17.08.2018	31 days
2.	Special International Training Course on Wind Resource Assessment & Wind Farm Planning	19.09.2018	12.10.2018	24 days
3.	Special International Training Course on Design, Installation & Maintenance of Small Wind Turbine	14.11.2018	14.12.2018	31 days
4.	23 rd International Training Course on Wind Turbine Technology and Applications	30.01.2019	01.03.2019	31 days

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

International training course on "Design, Installation and Maintenance of Small Wind Turbine" specially for African countries under AIFS –III scheme scheduled during 15th November to 13th December 2018

23rd National training course on "Wind Energy Technology" scheduled during October 2018 and 24th National training course on "Wind Energy Technology" scheduled during March 2019

Special Training Course on "Wind and Solar Resource Assessment Technology" Exclusively for SNA's Officials scheduled during February / March 2019

Students Internship / Project Work

Internship:

- 11 students, B.E (EEE), Jerusalem College of Engineering on EcoSense System from 1st to 25th June 2018 have completed the internship.
- 8 students, B.Voc (RE Mgmt.) from Tezpur University, Assam on EcoSense System on Measurement & Analysis have completed the internship.
- 2 Students from Jeppiaar Engineering College, Chennai on Econsense System have completed the internship.
- 3 students, B.Voc (RE) from Dayalbagh Educational Institute (Deemed University), Agra on EcoSense System, have also completed the internship.

Visitors

To create awareness and to motivate towards research on wind energy, achieving the indigenization and also to create awareness about the activities and services of NIWE, schools and college students are encouraged to visit the campus. During the period April to June 2018, the following visits was coordinated and facilities of NIWE were showcased and explained.

150 students, IX standard, St. John's Sr. Secondary School, Chennai on 19th April 2018.

GLOBAL WIND DAY CELEBRATIONS 2018

Global Wind Day is a worldwide event that occurs annually on 15 June and NIWE being the technical focal point for the development of wind energy in the country is celebrating Global Wind Day on every 15th June since 2009. This year, on 14th June 2018, on the occasion of Global Wind Day Celebrations, NIWE had conducted a One Day Workshop on Pan India Research Network – Industry & Academic Amalgamation at Chennai NIWE office. A brief background was presented to the members followed by address by Chairman and Members of R&D Council of NIWE. R&D activities and the expectations of the Industry / Academia / Research Institutes, specially on Wind Energy Sectors were also presented. And an Open Discussion Forum was conducted among Industry, Academia and Research Institutes.



RECRUITMENT

A.Haribhaskaran appointed as Scientist-C (Deputy Director Technical) in NIWE and has been placed in R&D Unit on 01.06.2018.

Wind Turbine Research Station



After completion of the total comprehensive preventive Operation and Maintenance works of various nature for the Wind Electric Generators installed at WTRS, Kayathar of capacity 6.4 MW comprising 9 nos 30 years old 200 kW MICON, 1 no 600 kW SUZLON, 1 no 2000 kW KENERSYS and 1 no 2000 kW INOX, all the Wind Electric Generators are being put in uninterrupted operation during the windy season 2018 along with break down maintenance works of the machines.

Solar Radiation Resource Assessment

Project Activities

- Dr. G. Giridhar along with IIM, Trichy officials had meeting with REC, New Delhi officials on 04.04.2018 in regard to the establishment of 2MW solar power plant at IIM, Trichy.
- Calibration of 5 pyranometers was carried out under SRRA project.
- Two Project Assistants carried out verification study along with ANERT officials on setting up of wind-solar hybrid plant at Ramakkalmedu, Kerala during 11.04.2018-15.04.2018.
- Site visit carried out at IIM, Trichy in connection with the DPR preparation during the period 20.04.2018-22.04.2018.
- Dr. G. Giridhar attended Expert Committee Meeting on Future Earth Observation Sensor Systems at Antariksh Vihar in New Delhi during the period 25.04.2018-26.04.2018.
- SRRA forecasting group officials attended one-day Brainstorming Meeting at IITM, Pune
- Dr. G. Giridhar attended SPC Meeting at Gangtok and Meeting with SLDC, Bangalore officials during the period 06.05.2018-15.05.2018.
- Mr. Karthik. R visited Ahmedabad for relocation of Gandhi Nagar SRRA station.
- STC meeting for the technical and financial bids received for setting up of 2 SRRA stations in Kerala (ANERT) held on 01.06.2018.
- Dr. G. Giridhar & R. Karthik had meeting with MNRE officials regarding launching of Mobile app during the period 04.06.2018-05.06.2018.
- Dr. G. Giridhar & Prasun Kumar Das inspected double axis solar tracking facility at Kumaraguru College of Technology, Coimbatore on 09.06.2018.

Overview of NIWE's Indigenous Wind Power Forecasting Model

Shri. S.A. Mathew, Director & Group Head, Testing & Forecasting, NIWE E-mail : mathew.niwe@nic.in

Shri.A.G.Rangaraj, Deputy Director(Technical), Testing & Forecasting, NIWE E-mail : rangaraj.niwe@nic.in

Background

In order to utilize the maximum of renewable resources and to increase the penetration and evacuation of wind power generation, a demo 51 MW wind power forecasting project was initiated during 2013 in association with M/s Vortex Spain through an Indo-Spanish research collaboration facilitated by MNRE, Government of India. NIWE commercially launched wind power forecasting services on 13th May 2015 in the presence of MNRE. Indian Wind Power Association (IWPA) approached NIWE to carry out forecasting of Wind power for the entire state of Tamil Nadu as per CERC norms in vogue. Accordingly, wind power forecasting is being delivered to TN-SLDC since September 2015 and the same is assisting Tamil Nadu's state-owned electricity generation and distribution utility, TANGEDCO, for better management of the fluctuations in wind power output in the Tamil Nadu region. As per the information provided by the Indian Wind Power Association (IWPA), about 12,884 Wind turbines with a total rated capacity of 7907 MW are under operational in the state of Tamil Nadu in 116 Substations across the state. Further, these substations are located mainly in the 4 sectors viz., Theni, Tirunelveli, Kanyakumari, and Coimbatore. The Windpower forecasting service plays an important role in the grid management activities of TANGEDCO such as allocation of balancing power, maintenance and scheduling of units of thermal power plants.

On the other hand, NIWE has developed an Indigenous wind power forecasting model with the help of high-resolution Numerical weather prediction (NWP) model data from the National Centre for Medium-Range Weather Research Forecasting (NCMRWF) and ISRO – Space Application Centre (ISRO-SAC). NCMRWF, ISRO-SAC, and NIWE are jointly working on improving the NWP model under various aspects. NIWE is receiving 25km (global model) and 4km (Regional Model) horizontal resolution NWP data with 50 m, 10 m and 3 Geopotential heights from NCMRWF. NCMRWF is providing hourly wind speed forecast up to 7 days ahead. In addition, NIWE is also receiving 5km (Regional Model) horizontal resolution NWP data for wind turbines connected substations in the state of

Tamil Nadu from ISRO-SAC. ISRO-SAC is providing 15 minutes wind speed forecast up to 72 hours ahead. NIWE has created a system to handle NWP data and actual generation data from various sources and also developed a hybrid physical and statistical model to estimate the wind power using NCMRWF / ISRO-SAC NWP data. By using the said model, NIWE established a system to predict the wind power up to 7 days ahead so as to support all the State Load Dispatch Centre (SLDC) in the country to evacuate wind power / manage the grid efficiently without any external Forecast Service Provider data. This indigenous model is currently under testing and validation. The model shall be made available to all the SLDC's in 2019 after appropriate fine-tuning to historical data of that particular state. Currently, NIWE is in the process of establishing Centre for Excellence in RE forecasting at NIWE, Chennai with the following objective.

- Initiating Wind Power Forecasting Services to the 7 States viz., Gujarat, Maharashtra, Telangana, Andhra Pradesh, Karnataka, Madhya Pradesh and Rajasthan.
- To absorb the maximum wind energy by the way of doing the wind power forecasting.
- Infrastructure Development and Capacity building to offer forecasting services to utilities.
- Establishment of National Data acquisition system to collect real-time WTG operational detail of NIWE.

In this article, the details of version 1.0 of NIWE's Indigenous wind power forecasting model (1 day ahead to 7 days ahead) has been elaborated.

NIWE Indigenous Wind Power Forecasting Model Framework:

The overall framework of NIWE indigenous wind power forecasting model is given in Figure 1.

Statistical Input

Historical Generation data

Historical Generation data will be used to understand the generation pattern in the immediate past of each wind farm / Wind pooling substation. This is one of the critical inputs to initialize the NIWE's Indigenous wind power forecasting

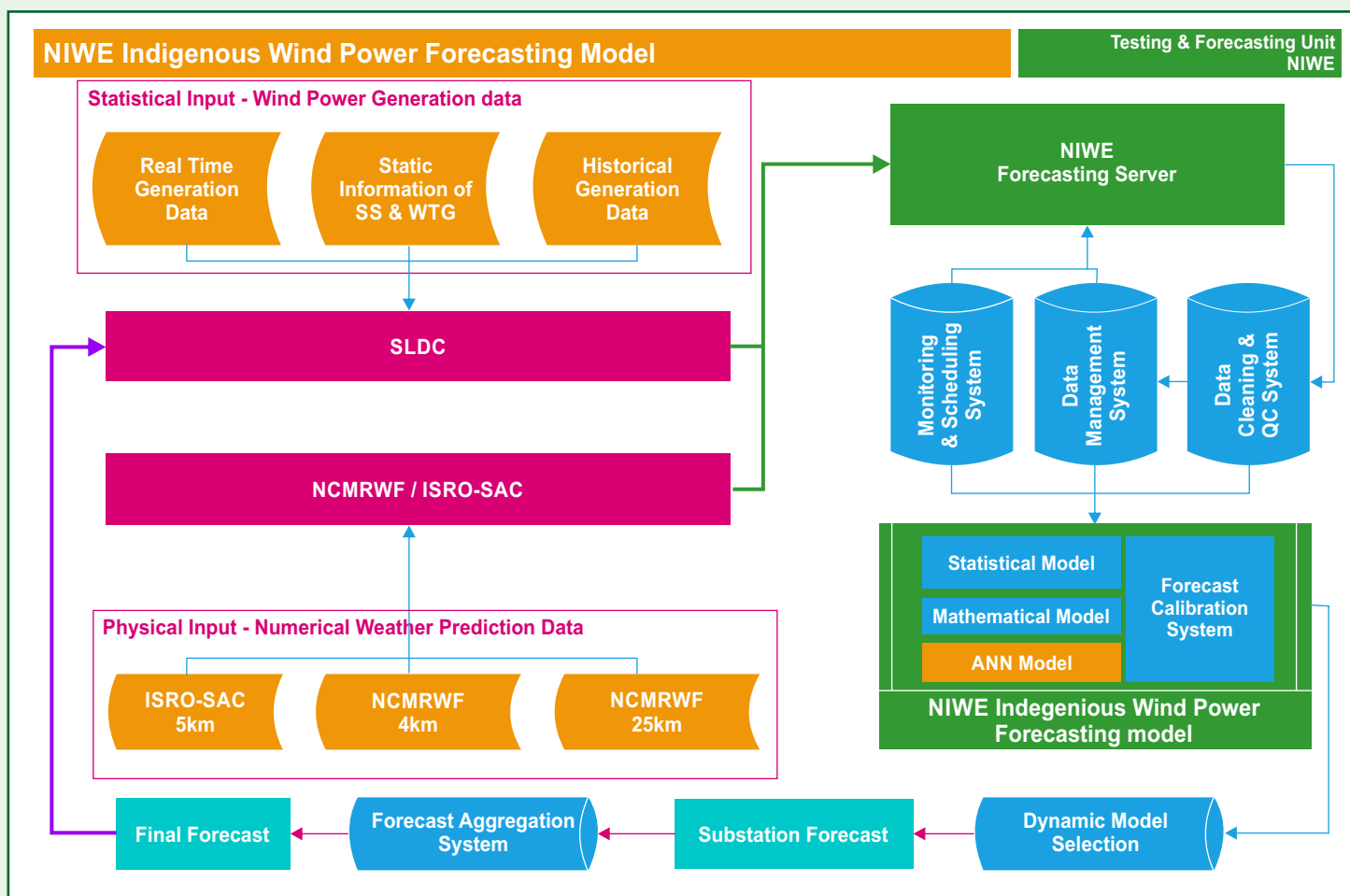


Figure 1 NIWE Indigenous Wind Power Forecasting Model Framework

model. Historical generation data shall be obtained from the past records maintained at the individual Wind Pooling Substations / Wind Farm SCADA system. For new substations or the station does not have proper historical generation data, NIWE will use the WTG co-ordinate details along with its Power curve information to initiate wind power forecasting model. The NIWE's model requires a minimum period of 1-year accurate historical generation data with a temporal resolution of the 15-minute interval. The accuracy of the forecast mainly depends on the accuracy of the historical generation data. Hence, the accurate Generation data will play a vital role in the wind power forecasting project.

Real-time data

Real-time wind power generation data will be used to calibrate the model output with recent observation and the same will be used in the Intraday forecasting model. This is one of the critical inputs to calibrate the NIWE's Indigenous wind power forecasting model. This data shall be obtained from the ABT (Availability base Tariff meter) / SCADA system

established in Wind Farm / through RTU (Remote Terminal Unit) fixed in the pooling substation. The critical parameter would be average active power generated in the pooling substation / Wind Farm and additional parameters viz., wind farm average wind speed, wind direction, Status of the turbine/feeder would be helpful to refine the forecast results. Currently, in the state of Tamil Nadu, REMC is receiving the feeder wise generation data of 116 numbers of wind farms connected substations with 3-minute interval and TANGEDCO has accorded access to these data by NIWE. On the other hand, GETCO has established the RTU mechanism in the 69 numbers of wind turbines connected pooling substation and provided access to NIWE to download the generation data of each substation with a 1-minute interval. NIWE established an automation system to collect, clean and process the generated data and we are storing the data in the master database with 15-minute interval.

Static data of Pooling substation

The static information such as Substation name, Capacity of

SS, Number of feeders, Transformer details, Latitude and Longitude of Substations etc., is essential to select the proper meteorological data from NCMRWF / ISRO-SAC, preparation of the substation level power curve and the information also being used to refine the forecast results.

Physical Input

NIWE is presently receiving Numerical weather prediction (NWP) model data from the National Centre for Medium Range Weather Forecasting (NCMRWF) and ISRO – Space Application Centre (ISRO-SAC) with a horizontal resolution of (4km,5km – Regional Model & 25 km - Global Model). The major Technical details are summarized here:

Sl.No.	Description of the property	ISRO-SAC (WRF Model)	NCMRWF (Regional Model)	NCMRWF (Mesoscale Model)
1	Initial Condition	Three dimensional for real-data, and one-, two- and three-dimensional using idealized data (terrain/several mountain-wave test cases/resolved moist deep convection /shallow atmosphere approximation)	Initial conditions are typically provided by a numerical synthesis of available observations.	Initial conditions are typically provided by a numerical synthesis of available observations.
2	Governing Equations	Nonhydrostatic equations with hydrostatic option	Non-hydrostatic equations	Non-hydrostatic equations
3	Spatial Resolution	$0.05^{\circ} \times 0.05^{\circ}$	$0.25^{\circ} \times 0.25^{\circ}$	$0.04^{\circ} \times 0.04^{\circ}$
4	Boundary Conditions	Top Boundary Condition: Gravity wave absorbing (diffuse or Rayleigh damping), at constant pressure level. Bottom boundary condition: Physical or free slip Lateral boundary conditions: Idealized cases: Periodic, open lateral radiative, and symmetric Real cases: specified with relaxation	Boundary conditions from NCEP -GFS	NCMRWF global (T80L18) analysis and 6 hourly global Model forecasts are used for initial and lateral boundary conditions
5	Microphysics	Kessler scheme, Lin et al. Scheme, Single-Moment 3-class scheme, WRF Single-Moment 5-class scheme, Eta microphysics, WRF Single-Moment 6-class scheme, Thompson et al. Scheme	An improved mixed-phase scheme based on Wilson and Ballard (1999)	An improved mixed-phase scheme based on Wilson and Ballard (1999)
6	PBL Process	YSU, MYJ, GFS, QNSE, MYNNx, ACM2, BouLac, UW, TEMF, MRF	Based on Lock et al., 2000 & Martin et al., 2000	JULES Revised PBL
7	Gravity Wave Drag	GWDO (The gravity wave drag induced by sub-grid scale Orography) parameterization considering low tropospheric enhancement (i.e, the parameterization suggested by Kim and Arakawa 1995)	Gravity-wave drag is simulated as described by Alpert et al. (1988)	Based on orography drag and spectral gravity wave (Webster et al., 2003)
8	Time integration	3 rd -order Runge-Kutta time integration scheme	Semi-implicit time stepping	Semi-implicit stepping

Sl.No.	Description of the property	ISRO-SAC (WRF Model)	NCMRWF (Regional Model)	NCMRWF (Mesoscale Model)
9	Spatial Discretization	Arakawa C-grid	Simplified-Arakawa Scheme	Finite Difference method
10	Data Assimilation	Variational data assimilation (3D-Var and 4D-Var)	4-Dimensional Variational Method (4D-Var)	4-Dimensional Variational Method (4D-Var)
11	Radiation Parameterization	Long wave - RRTM scheme, GFDL scheme, CAM scheme Shortwave - Dudhia scheme, Goddard shortwave, GFDL shortwave, CAM scheme	Longwave- Rapid Radiative Transfer Model (RRTM) Developed at AER (Mlawer et al. 1997) Shortwave - Radiative transfer parameterization is based on Hou et al., 2002.	Spectral band radiation (general 2-stream) called at every hour (The radiation code is used to calculate the radiative fluxes from which heating rates and related quantities are determined. In this radiation scheme, the fluxes are determined using a two-stream approximation (in which the angular variation of the diffused radiance field is represented simply by an upward and a downward flux). The spectral files are independent of the spatial resolution of the model.)

Indigenous Wind Power Forecast Model Framework - Process

November 8, 2017

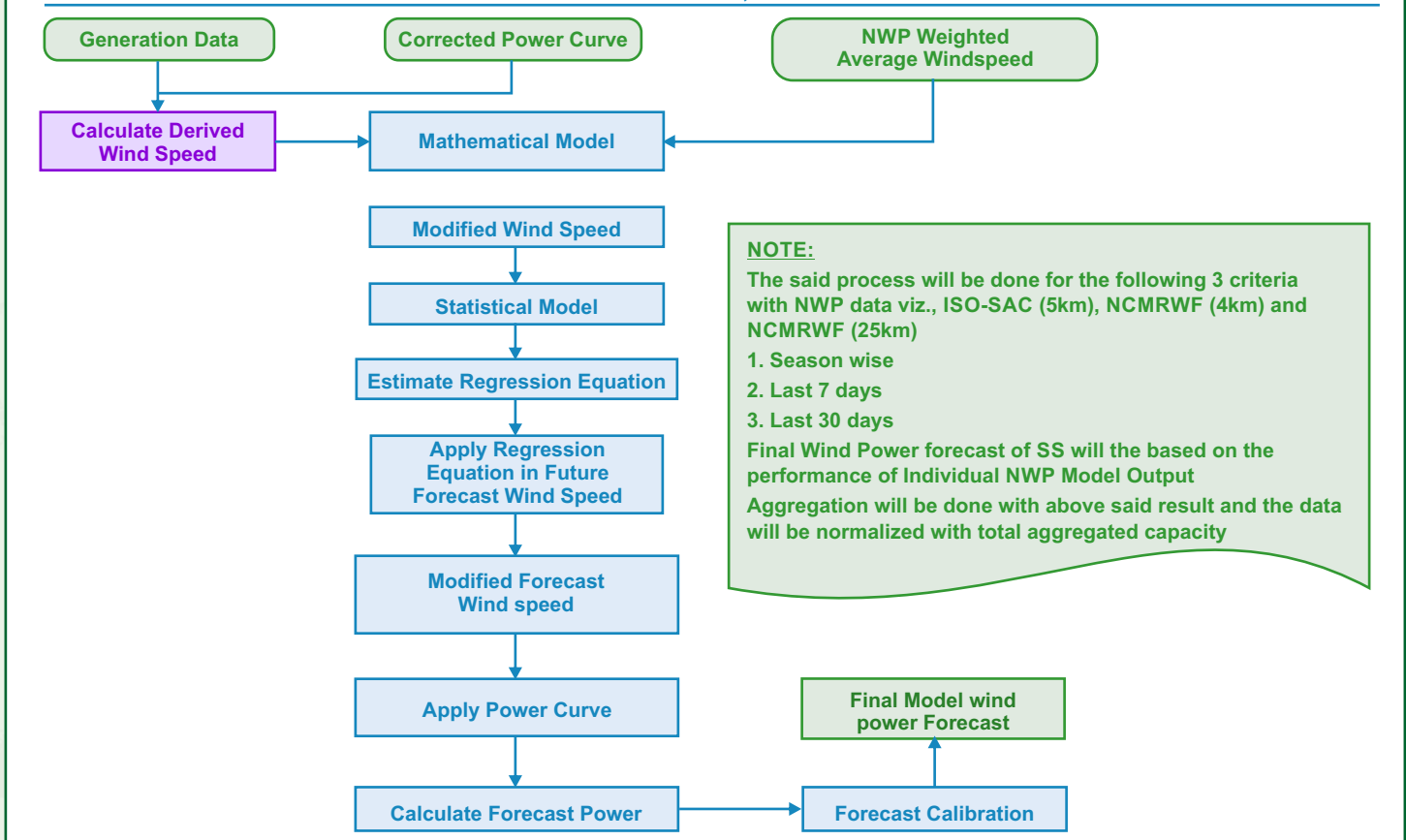


Figure 2 Workflow of Indigenous Wind Power Forecasting Model

Model operation

The NIWE forecast system is automatically downloading the NWP data from ISRO-SAC (5km resolution), NCMRWF (4km and 25km resolution) and carrying out temporal interpolation using climate data operator (CDO) model. Forecast system is operating in 2 Phases viz., a Training phase and operational phase. During the training phase, NIWE is carrying out data cleaning and calibration of the NWP data with one-year historical generation data. Using Statistical and Mathematical models, NIWE is fitting the equations for co-relations of the data set with different statistical approaches and identifying the best fit which can be used in the operational phase to correct the NWP data. In the operational phase, after applying necessary correction in NWP data, the forecast power is predicted with the help of a power conversion algorithm. The same process shall be repeated for the 3 different NWP data source and the results are being calibrated with the recent actual generation data. The best model output will be selected for each pooling substation with the help of a dynamic model selection algorithm developed by NIWE. The aggregation system is used to calculate the aggregated forecast and the forecast result will be delivered to the respective SLDC at the prescribed time. The detailed workflow of the model is given in figure 2.

Monitoring System

The monitoring system developed by NIWE is assisting the team to monitor the live update of various data.

408 views

NATIONAL INSTITUTE OF WIND ENERGY

MINISTRY OF NEW AND RENEWABLE ENERGY

WIND POWER FORECAST MONITORING SYSTEM



GOVERNMENT OF INDIA
Ministry of New and Renewable Energy
(Department of Wind)

408 views

REFRESH

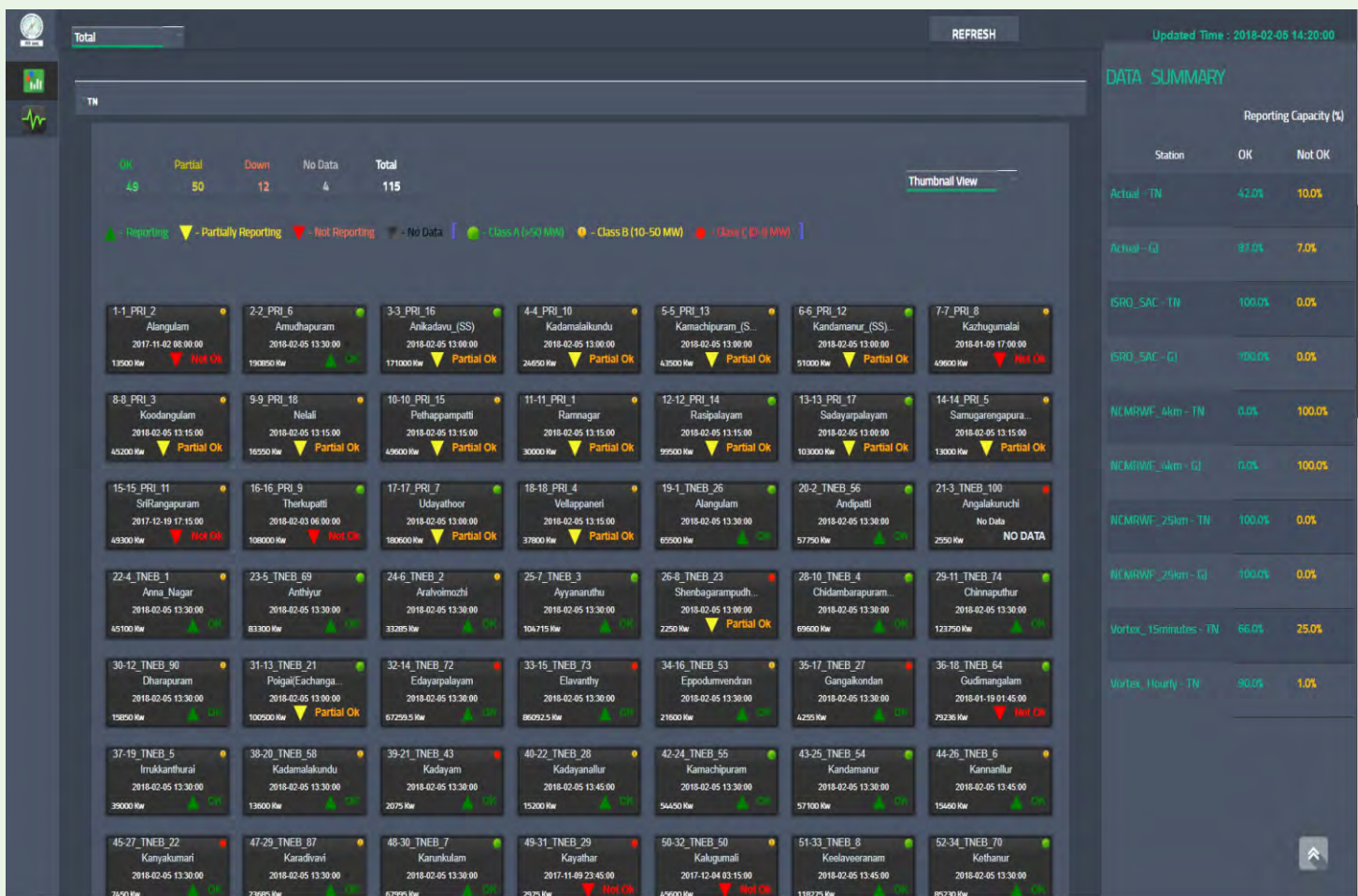
Updated Time : 2018-02-05 14:14:05

DATA SUMMARY

Station Description	Reporting Capacity (MW)					Reporting Station(nos)					Reporting Capacity (%)			
	OK	PARTIAL	NOT OK	NO DATA	TOTAL	OK	PARTIAL	NOT OK	NO DATA	TOTAL	OK	PARTIAL	NOT OK	NO DATA
Actual - TN	1465	3774	537	156	5931	27	72	12	4	115	23.0%	62.0%	10.0%	3.0%
Actual - GJ	3772	901	129	4	4807	60	4	5	1	70	85.0%	5.0%	7.0%	1.0%
ISRO_SAC - TN	5931	0	0	0	5931	115	0	0	0	115	100.0%	0.0%	0.0%	0.0%
ISRO_SAC - GJ	4807	0	0	0	4807	70	0	0	0	70	100.0%	0.0%	0.0%	0.0%
NCMRWF_4km - TN	0	0	5931	0	5931	0	0	115	0	115	0.0%	0.0%	100.0%	0.0%
NCMRWF_4km - GJ	0	0	4807	0	4807	0	0	70	0	70	0.0%	0.0%	100.0%	0.0%
NCMRWF_25km - TN	5931	0	0	0	5931	115	0	0	0	115	100.0%	0.0%	0.0%	0.0%
NCMRWF_25km - GJ	4807	0	0	0	4807	70	0	0	0	70	100.0%	0.0%	0.0%	0.0%
Vortex_15minutes - TN	4303	0	1424	204	5931	77	0	29	9	115	66.0%	0.0%	25.0%	7.0%
Vortex_Hourly - TN	5542	0	185	204	5931	104	0	2	9	115	90.0%	0.0%	1.0%	7.0%

551

Figure 3 Screenshot of Monitoring Page



NIWE is sharing the forecasting result through FTP, e-mail and through the dedicated forecasting portal. Any general public can view the aggregated forecast for the next 7 days from the wind power forecasting portal.

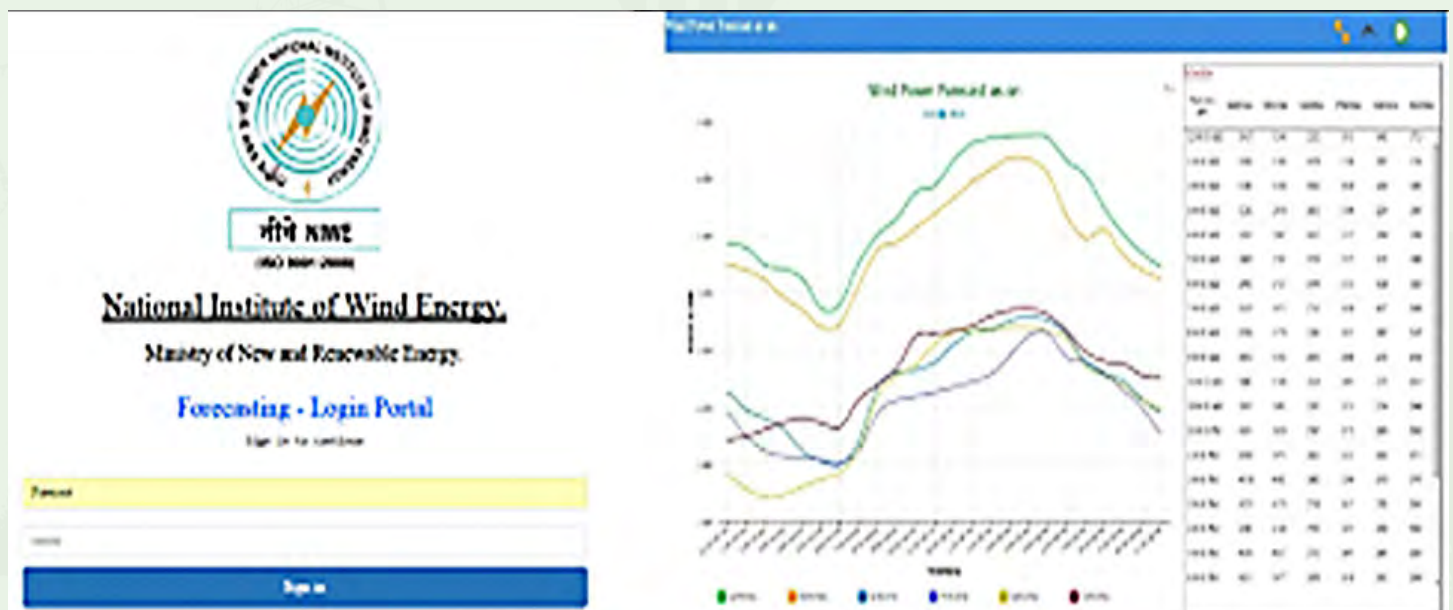
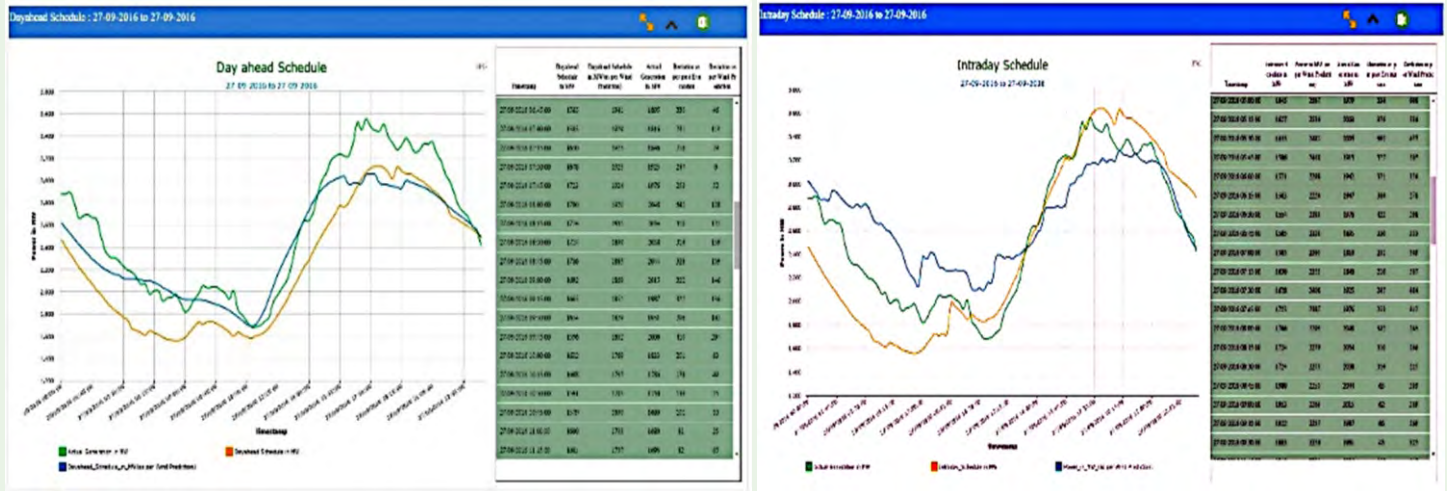


Figure 4 Screenshots of Windpower Forecasting portal of NIWE



Model Testing

NIWE has trained the model with 2015 and 2016 data and carried out the model simulation from Jan 2017 to Dec 2017 in order to assess the performance of the model. The tested results are given below in Figure 6:

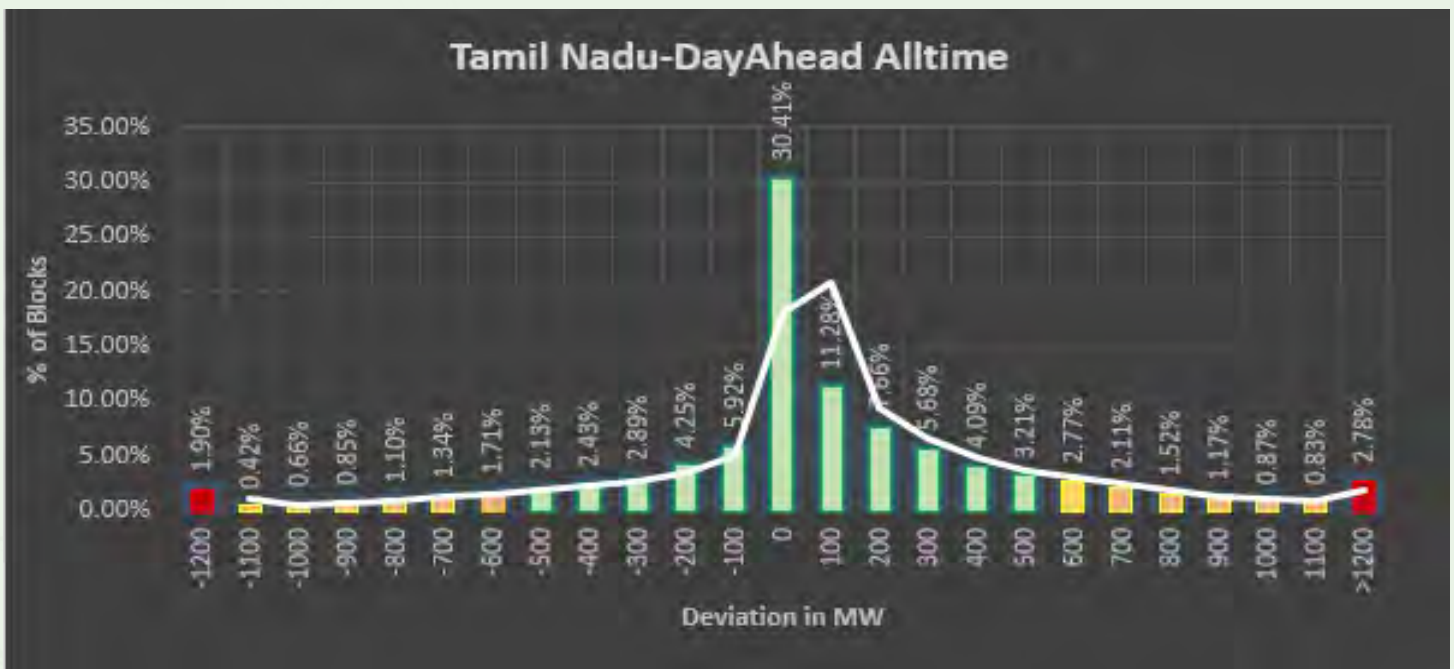


Figure 5 Tamil Nadu Day-ahead error analysis

As indicated above, 80% of blocks, the day ahead forecast deviation is within 600 MW (7.5% of Installed capacity) and 95% of blocks, the day ahead forecast deviation is within 1200 MW.



नीवे NIWE

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An autonomous R&D Institution under the Ministry of New and Renewable Energy (MNRE), Government of India
Velachery - Tambaram Main Road, Pallikaranai, Chennai - 600 100.

Phone : +91-44-2246 3982, 2246 3983, 2246 3984 Fax : +91-44-2246 3980

E-mail : info.niwe@nic.in URL : <http://niwe.res.in> [www.Facebook.com/niwechennai](https://www.facebook.com/niwechennai) [www.Twitter.com/niwe_chennai](https://www.twitter.com/niwe_chennai)

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