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CENTRE FOR WIND ENERGY TECHNOLOGY
C-WET
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A News Bulletin from CENTRE FOR WIND ENERGY TECHNOLOGY, Chennai

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EDITORIAL

With the world exploiting the green energy sector with wind power leading the development, the uncertainty to "wind as a reliable resource" and its variability are still a matters of serious concern. The State Electricity Boards claim that wind power is excellent but infirm. The State of Tamil Nadu has the largest installed capacity of over 4500 MW in India. The Tamil Nadu experience shows that the wind energy penetration can be up to 15% and even higher up to 20%, if adequate spinning resource is available. During 2007-08, the total wind power injected to the Tamil Nadu grid was 6250 million units amounting to 9.6% of the total grid input without causing detrimental impact on the state grid which is connected to the southern region. It also shows that impact is manageable with appropriate network inter-connection through regional and national grids. Keeping in view the provisions contained in the Electricity Act 2003, the Forum of Regulators (FOR) has recommended development of appropriate technical standards for grid connectivity for renewable energy based power stations, facilitation of grid connectivity by transmission licensees/distribution licensees for renewable energy sources in an optimum manner through their capex plans and setting up of co-ordination mechanism for renewable energy in State Load Despatch Centre (SLDC) and State Transmission Utility (STU) to ensure smooth operation and grid integration of renewable energy sources. Accordingly, C-WET has initiated development of grid-code for wind electric generators in association with various experts/expert organizations.

C-WET in its endeavour to promote wind energy, continues its Wind Resource Assessment in several areas including remote locations. To keep pace with current trend of increased hub heights in modern wind turbines, C-WET's WRA unit has installed and commissioned two 120m masts from which multi level wind data has already started coming in and the analysis of the data is in progress.

With the acceptability of wind as one of the green sources of power having only fixed cost with a zero variable cost, there are several new players coming to India. C-WET's Standards and Certification unit is continuously facilitating the entry of several new wind turbine manufacturers. It is heartening to note that the manufacturing capability of wind turbine sub-components in India are steadily on the increase and C-WET's expertise is sure to supplement this activity further.

Experiments are ongoing on a stall regulated constant 'RPM' Wind Turbine installed at Kayathar. The Research and Development unit is organizing several sub-group meetings to finalize the needy areas of R&D in the wind power sector in India. Research will be co-ordinated by C-WET and executed by specialist institutions and from academia.

The ITCS Unit of C-WET has completed a series of training programmes during this period. It is my pleasure to intimate the readers that C-WET is awarded a "Special Institution Recognition Award" for the year 2008 by World Institute of Sustainable Energy (WISE) in the Wind India 2008 International Conference and Exhibition held at Chennai recently.

I take this opportunity to introduce C-WET's new Executive Director, Dr. S. Gomathinayagam on absorption from Structural Engineering Research Centre, CSIR, Chennai, who will be taking charge on January 2009. He will continue to contribute to the publication of PAVAN in future, and look forward to your valuable feedback.

K.P. Sukumaran
Executive Director

Contents

Editorial Board

Developments in R&D UNIT

R&D in the XI Five Year Plan

In order to lay impetus on further growth of wind energy in the country, a brainstorming session on 'R&D needs of wind energy' was conducted under the chairmanship of Dr. Kota Harinarayana. It was felt that a strategic plan be formulated for R&D with serious efforts from industry, academia and R&D institutions, wherein C-WET would play a co-ordinating role. Sub-groups consisting of experts in various fields related to wind energy were constituted to lend their expertise to thrust areas, as mentioned below indicating areas of research identified for which proposals are solicited.

Wind Turbine Components / New and Alternate Materials for Construction

- Blade
- Tower / Mast
- Generators and Grid Integration of Wind Turbines
- Gearbox
- Human Resource Development

A. Certificate Courses of six months duration :

1. (a) Operation & Maintenance (Mechanical)

   (b) Operation & Maintenance (Electrical & Electronics)

2. Blade Manufacturing

B. Post graduate Diploma Courses of nine months duration:

1. Project planning, management and implementation
2. Wind resource analysis

C. Masters level course of 2 years duration:

Electives in Wind Engineering will be offered with the following courses:

a) Masters in Engineering Design

b) Masters in Power Electronics.

To begin with, the courses will be implemented in PSG College of Technology, Coimbatore and Amrita School of Engineering, Coimbatore. For the purpose, a detailed proposal has been submitted by PSG College of Technology to MNRE :

- Hybrid Systems
- Research in Wind Resource Assessment
- Condition Monitoring of Wind Turbine

Move on in WRA UNIT

120 m Anemometry at three locations

In order to measure the wind shear at some of the major wind farm locations and to serve as long-term reference stations, a project was sanctioned by the Ministry to commission five 120 m tall masts in Tamil Nadu, Karnataka, Maharashtra, Gujarat and Rajasthan. At present, three wind monitoring stations have been commissioned one each in Maharashtra (Jagmin, Satara District), Gujarat (Lamba, Jamnagar District) and Rajasthan (Akal, Jaisalmer District). Anemometers are installed at 5 levels and wind vanes at 3 levels. Apart from these, sensors for measuring temperature, pressure and solar radiation are also attached. The stations are also equipped with remote data downloading facility.

120 m mast installed at Jagmin, Maharashtra

During the period of October to December, 8 new wind monitoring stations in six States have been installed. Presently, 86 wind monitoring stations are operational in 17 States and one in Union Territory under various wind monitoring projects funded by the Ministry and Consultancy projects etc.

Verification of Procedure of independent Wind Monitoring at Soda Bandhan, Jaisalmer District in Rajasthan (for M/s. Suzlon Energy Limited, Pune), Gangadevi, Beed District in Maharashtra (for M/s. Vestas Wind Technology India Private Limited, Chennai), Pohra site in Rajasthan & Akal site in Rajasthan (for M/s. RRB Energy Limited, Chennai), Sadawaghapur, Satara District in Maharashtra and Sadawaghapur Forest, Satara District in Maharashtra (for Suzlon Energy Ltd., Pune) have been undertaken during these months.

The unit has completed 6 nos. of "Verification of Procedure of Wind Monitoring" at Jagaravalli (Hasan District, Karnataka), Modurgudda (Hasan District, Karnataka), Gangadevi (Beed District in Maharashtra), Kondamedapalli (Kurnool District, Andhra Pradesh), Vedganga (Kolhapur District, Maharashtra) and Nallakonda (Anathapur District, Andhra Pradesh).

Technical Evaluation of Micrositing of the proposed wind farm project in Maharashtra for Bharat Petroleum Corporation Limited, Noida and Power Curve guarantee test of Wind Turbine Generator installed at Wind Farm of M/s. CPCL at Pushpathur, Tamil Nadu, have been carried out during the period.

Steps forward in TESTING UNIT

- The measurements and reporting for type testing of Siva 250 kW wind turbine at WTTS, Kayathar and IWPL 250 kW wind turbine at Navadra, Gujarat have been completed.
- The Instrumentation of Chettinadu 600 kW wind turbine of M/s.Chettinadu Energy Ltd. at Thirumangalakurichi, Tamil Nadu has been completed.
- The measurements of CWEL 250 kW wind turbine of M/s. Chiranjjeevi Wind Energy Ltd. at Chithambalam, Tamil Nadu have been completed and analysis is under progress.

Marching ahead in S&C UNIT

- The project on "Review of documentation on outstanding issues for Pawan Shakthi 600 kW wind turbine model" has been completed.
- Revised List of Models and Manufacturers of Wind Electric Generators/Wind Turbine Equipment (RLMM) has been issued on 16-12-2008.
- The certification projects, taken up as per TAPS-2000 (amended) are under progress.
- The continual improvement and maintaining the Quality Management System are ongoing.

Highlights from ITCS UNIT

ITCS unit has prepared panels explaining the objectives, activities and services of C-WET and installed a stall in "Wind India 2008" International Conference-cum-Exhibition organized by World Institute of Sustainable Energy, Pune during 25th & 26th November 2008 at Chennai Trade Centre, Chennai. Lots of participants visited the stall and obtained the information about C-WET and its services. The technical explanation at the stall was well appreciated.

Snaps of C-WET Stall

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C-WET

A News Bulletin from Centre for Wind Energy Technology, Chennai

Wind Turbine Testing

Shri David Solomon, Scientist, Testing Unit of C-WET

(i) Genesis

C-WET came into existence in the year 1998 to assuage the long felt need by various stakeholders of the field of wind energy for a centre of excellence, to regulate the growth in this sector and also to act as the technical focal point in this sector. Prior to this period of time, the various state nodal agencies in tandem with the Ministry of Non-Conventional Energy Sources (MNES) were handling the issues arising in the wind sector and in hindsight the experience was that there existed no mechanism to verify scrupulously the design aspects of the models being erected in India. The interest of all the stakeholders in the wind engineering spectrum needed protection. Designs certification helps to a large extent to safeguard the interest of all stakeholders. It enables the assessment of commercial viability of a Wind Turbine - for a manufacturer, the establishment of an optimal performance availability both in generation & life, for an entrepreneur to plan a successful venture; the assessment of the turbines' safety provisions ensures the operator's confidence in handling the turbine and increases and assures on the quality of power fed to the utility grid enhancing a consumer's confidence to co-exist in the grid. As a consequence, a facility to provide such service became the need of the hour. One of the main charters of C-WET's work was to vet new prototype designs or for models already in vogue, which have undergone critical design modifications, before they go commercial and issue certificates of worthiness for their configurations. This requires a prototype facility to test and release reports based on which certification of the wind turbine model can be accorded. C-WET's Testing Unit was established as Wind Turbine Test Station (WTTS) at Kayathar to do this work at the time of its inception. The test reports from the test facility can also be used when validation is mandated as a part of a multiparty adjudication. The testing unit was required to be an accredited setup, adhering to internationally accepted & benchmarked code of conducts, to conduct/produce the required tests & reports.

Any laboratory to perform these test activities need, not only adhere to internationally peer reviewed & accepted standards/ guidelines but also should be accredited, so that the results thus produced are accepted by one and all. One among the few existing societies that provide wind turbine related standards is the International ElectroTechnical Commission (IEC). IEC has produced a series of standards/Technical Specifications that regulate the way the tests on the wind turbines could be conducted by labs across the world. Testing unit follows the relevant IEC standards in their entirety for conducting its tests. While setting up the Wind Turbine Test Station, C-WET took the expertise from RISO – an accredited lab from Denmark, for 5 years starting from 1999 to learn the nuance of the trade. The transfer in expertise from RISO to C-WET was based on hands-on training in all spheres starting from instrumentation to data acquisition to analysis & reporting, under the constant tutelage and guidance of the RISO experts. Engineers were trained at the test bed of the unit as well as at RISO's test beds in Denmark. To follow the IEC standards or for that matter any other internationally accepted standard inside the lab doesn't make it competent but, as stated earlier, an accreditation of its competence to do so also matters. C-WET developed a series of procedures, formats & record documentation system coupled with an exhaustive equipment inventory system which was mostly the translation of the hand-on-training, from the RISO, into letters. C-WET's testing unit went in voluntarily for getting itself accredited in the year 2003 after having a working array of system and personnel in place. By 2004 C-WET's Testing unit was accredited by DNV for working in conformance as per the requirements of ISO 9001:2000 and then the Testing Unit initiated the next logical step of going in for a National Accreditation Board for Testing and Calibration Laboratories (NABL) accreditation, for a conformance as per ISO/IEC 17025:2005 of its technical competence. Starting with a rigorous schedule of streamlining the existing work procedures and then following it up with a strenuous NABL audit, the testing unit earned its accreditation from NABL in the year 2005. The second renewal audit was conducted in 2007 and fresh conformance certificate in the unit's name was issued in 2008, valid till 2010. NABL being a qualified APLAC MRA (Mutual Recognition Arrangement) Partner as well as a Signatory to ILAC (International Laboratory Accreditation) Arrangements gave the Testing units reports the much needed international acceptance. This helped remove the technical barriers to the acceptance of our tested product anywhere across the globe and gave a "tested once and accepted everywhere" quality to Testing Units' test reports.

(ii) The Unit

The Wind Turbine Testing Unit is equipped with state-of-the-art sensory & data acquisition system to record the tests and the unit boasts a permanent test bed which is one of its kinds in the whole of Asia Pacific region. Trained personnel can now conduct the tests with world class proficiency. The tests can be conducted both at the permanent Test Beds of the Unit as well as at the sites of the customer, based on the customer's request. The Unit receives more requests to conduct type tests at the customer's location since the cost of relocation and other inconveniences on their part could be avoided by this.

The unit is capable of carrying out the following tests as per the requirements of IEC 61400-12-1, TS 61400-13, 61400-1 and Danish recommendations. A test plan is drafted and concurred upon before starting the type testing once the agreement with the customer to take up his turbine for test has been signed. The agreement would detail the parties entering upon the work and the obligations on their part to help conduct the test without any delinquency. The test plan elaborately details a series of tests that would be conducted along with the details of the sensory setup proposed to be deployed by the unit on the turbine to measure and collect the data. The test plan also details the time schedule that would be adhered to.

(iii) Capabilities

The following are the plethora of tests that the unit currently is capable of conducting:

(a) Power Performance measurements
(b) Safety and Function testing
(c) Yaw efficiency
(d) Load Measurements &
Special measurements as required by the customer.

(a) Testing unit does Power Performance measurements using IEC 61400-12-1 which provides a uniform methodology that will ensure consistency, accuracy and reproducibility in the measurement and analysis of power performance by wind turbines. The Testing unit uses this standard to meet the following common requirements (a) a wind turbine manufacturer's quest to meet well-defined power performance requirements, (b) a wind turbine purchaser's tryst to find its performance or to verify whether the stated or required power performance specifications are met for new or refurbished units, (c) a wind turbine planner or regulator who wants to accurately and fairly define power performance characteristics of wind turbines in response to regulations or permit requirements for new or modified installations. This standard presents measurement and reporting procedures expected to provide accurate results. A key element of power performance testing is the measurement of wind speed. The unit follows the prescribed standard cup anemometer model to measure the wind speed. The instrument used by the unit comes from RISO, which is robust and has long been regarded as suitable for this kind of test. It has excelled itself as a capable sensor when put to round robin tests along with other makes inside MEASNETs' comparative studies. Even though suitable wind tunnel calibration procedures are adhered to, the field flow conditions associated with the fluctuating wind vector, both in magnitude and direction will cause different instruments to potentially perform differently. The Unit gets its anemometers calibrated from MEASNET Certified facilities in Europe. Shown below are the testing personnel working on a Wind Turbine under test and mounting the sensors to establish a complete measurement setup:



The rest of the sensors used in the measurements are procured based on the IEC recommendations & RISO's expert advice and are calibrated from labs holding only ILAC MRA & a copy of the details is enclosed in the reports produced by the unit for the corresponding test. A complete uncertainty level is estimated for the measurements due to all the contributing factors like the sensors' mounting to the data acquisition systems & signal handling capability and is reported in the final test report. All the equipment sensors are held along with the signal cables & acquisition units at the Testing units' Turbine test station at Kayathar. This facility is located geographically at a location away from industrialized hubs in South India, such that the environment is cleaner and hence normal troubleshooting & maintenance schedules due to degradation in the instrumentation are mostly averted. The personnel manning this station perform the needed pre-instrumentation checks and post dismantling maintenance activities on all the systems & components. Logs as required by ISO and NABL are maintained by the personnel.

(b) Another important test that the lab performs is load measurements. During the process of structural design of a wind turbine, thorough understanding about, and accurate quantification of, the loading is of utmost importance. In the design stage, loads can be predicted with aeroelastic models and codes. However, such models have their shortcomings and uncertainties, and they always need to be validated by measurement. Furthermore, measurements can be used for the direct determination of structural loads in specific conditions. Mechanical load measurements can be used as the basis for certification. Design aspects for wind turbines are covered by IEC 61400-1 whilst certification procedures are described in IEC WT 01. The testing unit uses IEC 61400-13 technical specification, which helps the test engineers to implement the test to meet the specific design for certification needs. The specification provides the unit with specific guidance on load measurements on key structural components and load paths, which are strictly adhered to. The unit uses strain gage technology developed & marketed by world leaders like HBM of Germany and Vishay Micro Measurements of USA to deduce the loads in key components and flow paths. The details of the deployment are detailed in the test plan along with the kind of strain gages being used. Data analysis procedures are also outlined and the unit adheres to them strictly. Codes written in Delphi language are used to decipher the loads and estimate the equivalent loads, from which the fatigue life of the turbine can be deduced. Based on the specification, the methods to collect various types of time-series or statistical load information are predetermined & organized by the testing unit. The measurement computers run on windows platform with tailor made NI front end software called DaqWin, developed & validated by RISO. Shown below are the Testing personnel, working on a strain gage installation:



Two types of situations are considered during load measurements – steady-state operation and transient operation. The prescribed measurement load cases mirror the design load cases within IEC 61400-1, the wind turbine safety standard. The data collected during measurements are retrieved and analysed as per the IEC standards and the reports in the prescribed formats are presented as the net output.

© The safety and function test conducted by the unit is guided by the "Recommendation for Basic Tests according to the Technical Criteria for Type Approval and Certification for Wind Turbines in Denmark" and records of the specific properties of a Wind Turbine with regards to its energy production and protection are documented. The generic actions of the turbine and its reactions during inducement of faults/generation of alarms are simulated and the responses recorded during the test. The unit avails itself of the wind turbine's safety philosophy from the customer during the signing of the agreement for testing and then in consultation with them drafts the Test plan which describes the tests that would be done. Some of the tests like cut-in current measurements need a faster sampling rate to capture all the electrical transients and hence the unit uses its fast sampling tools which are capable of a sampling frequency rate of 1500 Hz. The normal measurements are done at 35 Hz sampling. The rates of sampling are detailed in the test plan by the unit.

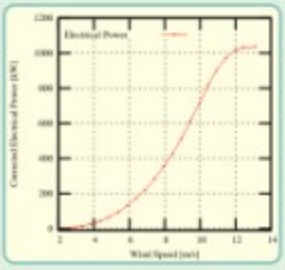
(d) Yaw efficiency test is another test that the unit conducts to document the difference between the wind direction and the turbine's yaw direction, to give a representation of the turbines ability to follow the wind accurately. A pronounced appearance of difference only indicates the potential loss suffered in the annual energy production as well as the excess loads induced in the turbine members due to the stochastic wind loads. Loss in production directly translated to revenue losses & excessive loads cause the reduction of functional life of wind turbine thus affecting the viability of the venture.

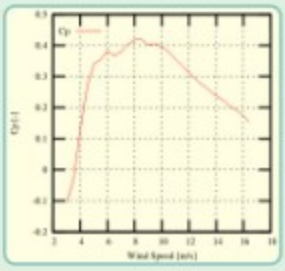
(iv) Reporting

The reports documenting the test results form the basis for certification of a design, inference about the capability of a wind turbine. Testing unit does not consider it within its scope to deduce any inferences or opinions based on the measurements it has documented owing to its proprietary nature. It purely reports the measurements in the prescribed formats. Customers are given the choice to approach any certification labs with the report from the Testing unit for getting there wind turbines certified, even though a certifying unit is available in house. The data collected & the reports produced from the tests are considered proprietary items and are hence never shared with any third party other than customer. The confidentiality class is strictly adhered to even during the process of the test. The Testing unit works as a cohesive unit, wherein all the activities of the tests from pre-instrumentation to release of the reports are cross checked by peers and the corrections enforced with pertinent care to avoid any deviations from the IEC regulations. All deviations beyond the control of the unit like measurement sector, non-availability at customers' site are reported in the annals of the test reports. The reports are labeled with unique identification code, as per the prescribed syntax, to avoid ambiguity, as per ISO quality system in place.

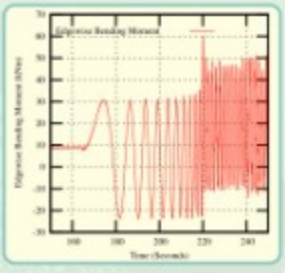
A few nuggets from the test reports documenting the test results are depicted as follows:

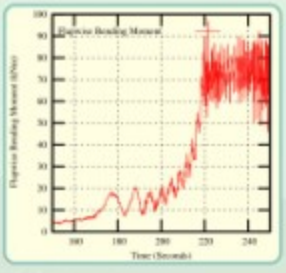
(a) Power performance & efficiency characteristics:



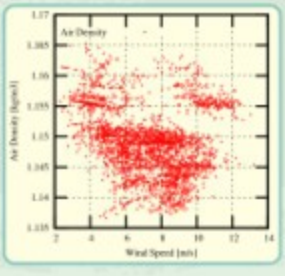


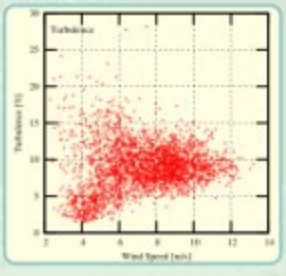
(b) Loading spectrum on critical regions of the turbine





(c) Measures of metrological parameter & there derivatives:





(v) Test Beds

The permanent facility of the testing unit, Wind Turbine Test Station (WTTS) is located at Kayathar about 100 kms north of Kanyakumari, the southern most tip of India. Salient features of the permanent test facility are:

1. Test station has currently two test beds with grid connection, to test wind turbines up to 1250kW and 400kW capacities. The number of test beds can be enhanced and higher capacity wind turbines can be tested when offered due to availability of ample space at the station.
2. Each test bed has a control room housing sophisticated data acquisition system coupled to state-of-the-art sensors and running on validated software.
3. Currently two adjustable met masts are available in front of each test bed and can be adapted to the hub height of the Turbine under test.
4. The terrain, which is in accordance to IEC 61400-12-1 requirements, gently slopes towards the west and is also the predominant wind direction for the test site. The wind season commences from April and extends till September, during which testing activities are scheduled and conducted. Since the winds are steady during the test period, turbulence has been well within limits.

Terrain views of the permanent test beds (WTTS, Kayathar) are shown below:

(vi) In-situ Projects

As stated earlier the unit is also undertaking in-situ tests with the same range of scope as could be done at its WTTS. The present trend among customers is to request in-situ tests rather than erect their wind turbines at WTTS test beds. With this trend raises new challenges like taking into consideration the deviation that will be arising from that of the requirements of IEC standards. These deviations need to be correctly addressed and accounted for in the uncertainty budget of the measurements. Turbines of MW class have been tested at terrains as varied as from the desert reqions of Jaisalmer, Rajasthan to the hillocks of Karunkulam, Kanyakumari. A few of the in-situ test locations:

(vii) Conclusion

The future challenge of the unit would be to keep in step with other leading labs. The Unit with all its capabilities and accreditation is still striving towards the utopian goal of attaining perfection in what it does. As a continual process of refining its capabilities, the unit is at the verge of attaining MEASNET membership. The international Measuring Network of Wind Energy Institutes (MEASNET) is a consortium of institutes which are engaged in the field of wind energy and want to ensure high quality measurements, uniform interpretation of standards and recommendations as well as interchangeability of results. Once a member, mutual and periodical quality assessments will be performed to harmonize measurements through inter lab evaluations and C-WET's testing unit can choose one of the member institutes for the desired measurements which will then be performed under the quality rules and requirements of the network. This would strengthen the working capabilities of the unit. Some of the esteemed members of this exclusive network are CENER of Spain, DEWI of Germany, ECN of Netherland, RISØ DTU of Denmark & NREL of USA. Once entry into this exclusive league by C-WET is achieved, then the paradigm shifts to maintaining this lead, for which the testing unit has to keep itself updated in the current trends of the instrumentation and start contributing towards providing valid inputs for expanding the current IEC standards' scope of work and deepening the existing standards' scope to acquire and analyse raw data. This would require the Testing unit to move away from being only a measurements lab and to become a place where extensive R&D work spheres are identified and pursued with diligence.

Special Institution Recognition Award

C-WET has been awarded the "Special Institution Recognition Award" by the Wind India 2008 – International Conference and Exhibition being held at Chennai Trade Centre, Chennai organized by World Institute of Sustainable Energy (WISE), Pune. The Awards Ceremony was held on 25th November 2008 at Chennai Trade Centre, Chennai.

The Executive Director and C-WET officials receiving the award

Award Certificate

C-WET Event

Shri.V.R.Gireesh Kumar, Scientist-C, S&C unit was relieved from C-WET on 11.12.2008.

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CENTRE FOR WIND ENERGY TECHNOLOGY (C-WET)

An autonomous R&D institution established by the Ministry of New and Renewable Energy (MNRE), Government of India to serve as a technical focal point of excellence to foster the development of wind energy in the country.

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