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A news bulletin from Centre for Wind Energy Technology, Chennai

C-WET

Contents

Editorial

It is often felt that winds must be rather good along the Indian coast line. Many suggestions have come up starting with the 6000 Km plus coast line of India. On shore we have quite a presence and to cut a long story short, we are able to contain the risk element with reasonable accuracy and the investor can actually place some faith in projections and discuss 'on the ground' projects with confidence. This is based on nearly two decades of experience and technologies maturing. At this stage, India is about two to five years behind the European developments in the wind turbine technology. With the 'Ambassador Car' mentality we still patronize some of the earliest models because that is the way we are.

In the meanwhile Europe, with much of its land based possibilities used up started looking beyond its shores some time back. Europe has always been, it should be noted, a sea faring continent. Call it horse sense or a sense due to it's need based compulsions, serious efforts have been mounted in the countries around the North and Baltic seas. One of the deciding factors for the countries which were once famous for ship building was that the industry had difficulty in keeping up with cheaper alternatives from Asia. They have these highly developed production skills for mammoth structures and an almost genetic knowledge of how to handle conditions of sea. Added to this, the wind turbine manufacturing field was seeing a saturation of on-shore market. The next logical step was to put these two things together. This is precisely what is happening out there.

The first off-shore wind farm came up in Denmark during 1991 with eleven Bonus wind turbines with a rating of 450 kW each. By 2006 March the total installed off shore capacity around Europe was about 680 MW. On one hand it is possible to state that it is rather slow. On the other hand, it is also possible to attribute this to the emphasis these countries place on research and development particularly while developing new technologies. While working against schedules of time and money no compromises are made on satisfying one's self about robustness of the design. When one looks at the German plans of going into the sea to set up an off shore test station for wind turbines, the seriousness with which the program is being pursued will be realized. In Germany, it is essential to keep the installations quite far away from the coast and there was hardly any dependable wind data available from the region. A massive effort to obtain such data was mounted and a 130 m tall mast was set up on a specially built off-shore platform like structure. This was heavily instrumented and in about three years time they have collected extremely valuable information, which will form the basis of future development. An important point to note is that notwithstanding mathematical modeling capabilities, when it comes to massive investments, one goes in for real measurements.

In India, we have data collected along the coast line at about fifty locations and the measured wind power densities have been rather low even to merit on shore wind farming except some pockets. One location is Vivekananda Rock off Kanyakumari where a wind power density of 365 W/m2 has been recorded at 30 m elevation. Other is the order of plus 500 W/m2 at 50 m elevation at Rameshwaram. Again compared to 700 to 900 W/m2 off north seas and Baltic seas, the numbers are not very encouraging. However, to rule out the possibility of not having data from much higher heights from sea level, measurements need to be carried out at some distance from the coast line. Further planning should be taken up only subsequent to that.

M.P.Ramesh,
Executive Director

News

Wind Power Installed Capacity in India

Year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Installed Capacity (MW)	**902**	**969**	**1025**	**1167**	**1340**	**1628**	**1870**	**2483**	**3595**	**5335**

Source: WindPro June 2006 issue No: 104

WIND POWER GROWTH RATES IN TOP 10 MARKETS

Year	2001	2002	2003	2004	2005	Growth rate 2004-2005	4 years average growth
Germany	8754	11994	14609	16629	18428	10.8%	20.9%
Spain	3337	4825	6203	8263	10027	21.3%	31.9%
US	4275	4685	6374	6725	9149	36.0%	21.8%
India	1502	1702	2125	3000	4430	47.7%	31.8%
Denmark	2489	2889	3116	3118	3122	0.1%	6.0%
Italy	682	788	905	1265	1717	35.7%	26.5%
UK	474	552	667	907	1353	49.2%	30.6%
China	400	468	567	764	1260	64.9%	34.4%
NL	486	693	910	1079	1219	13.0%	26.4%
Japan	274	414	687	936	1078	15.2%	42.1%
Total top	22673	29010	36163	42686	51783	21.3%	23.0%

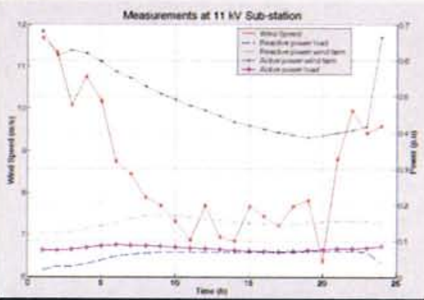
Source: Global Wind 2005 Report Pulished by Global Wind Energy Council

C-WET at Work

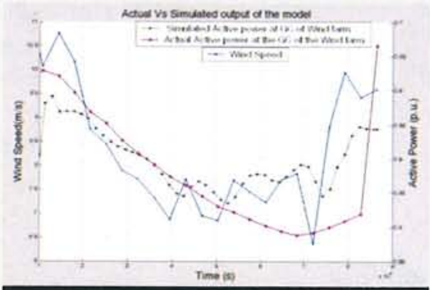
DEVELOPMENT IN R&D UNIT

Modelling on Interconnection of Wind turbines to grid

In the process of development of a simple tool to study the grid interaction of wind turbines, measurements were undertaken on 110/11kV Keelveeranam Substation to measure the grid parameters for validating the results of modeling. Parameters were measured at the Group control point, connected to three wind farm feeders and a rural load feeder. Data were recorded for steady state and transient events. Validation and fine tuning of the model is in progress. Results of the validation are shown below.



Measurements carried at 11kV Substatio



Actual Vs. Simulated Output of the model

Testing of Small Wind Turbines

A Test facility is being setup to under take testing of small wind turbines with swept area less than 200m2 at Wind Turbine Test Station, Kayathar. The proposed testing would be as follows:

Safety and function test

Duration test

Power performance test.

MOVE ON IN WRA UNIT

MNES is funding for 50 new wind monitoring stations

Fifty nine wind monitoring stations are under operation as a part of various programmes such as Power Law index (PLI) verification, Measure-Correlate Prediction (MCP) and National Wind Resource Assessment programme.

C-WET has prepared a background paper on "Offshore Wind Energy Assessment in India" and submitted to Technology Information, Forecasting and Assessment Council (TIFAC), Department of Science and Technology (DST), New Delhi.

Action has been initiated to commission 50 numbers of wind monitoring stations in 17 states of India under MNES programme.

STEPS FORWARD IN TESTING UNIT

The measurements of Suzlon 600kW wind turbine erected at WTTS Kayathar have been started in the month of May2006. The pre feasibility studies for testing three wind turbines under category II/III of the certification scheme in Gujarat have been carried out in the last week of June 2006.

The unit is planning to establish a small wind tunnel facility for the laboratory for carrying out functional and intermediate checks on metrological sensors shortly. The work for the working wind turbine model for training purposes is under progress. The unit was subjected to an exhaustive audit by NABL in the month of June 2006. The capabilities of the manpower and equipment of the unit were checked for conformity to the requirements of ISO/IEC 17025 and the unit has been awarded accreditation as per the requirements of ISO/IEC 17025.

MARCHING AHED IN S&C UNIT

The Renewal of Provisional Type Certificate for the wind turbine Vestas V-39 500 kW with 47 m rotor diameter of M/s. Vestas RRB India Limited, Chennai, has been completed.

The site evaluation has been carried out at Gujarat for the wind turbines Suzlon 1500 kW and Suzlon S 70/1250 kW.

S&C unit has organized the first meeting of the 'Working group on wind energy under BIS Non-Conventional Energy Sources Sectional Committee: ME 04' on 05.04.2006 at CWET, Chennai, to discuss the draft Indian standards on wind energy prepared by C-WET. The proceedings of first working group have been sent to BIS.

The Provisional Type Certificate of Pioneer Wincon W250/29-250 kW wind turbine model of M/s Pioneer Wincon Private Limited, Chennai, under category-I, as per TAPS 2000 has been issued by the Hon'ble Secretary, MNES on 29th April 2006.

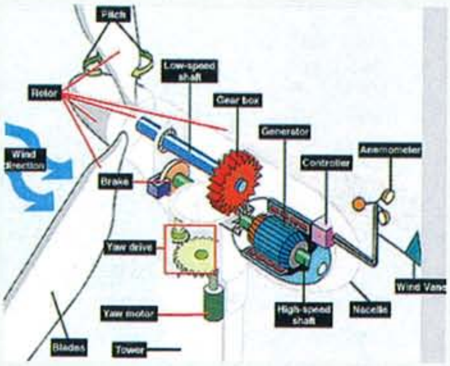
The certification projects, taken up as per TAPS-2000, are under progress.

The continual improvement and maintaining the Quality Management System are on going.

WIND TURBINE COMPONENTS

Most modern wind turbine includes the following principal components for electricity generation.

1) Rotor
2) Drive train
3) Nacelle
4) Yaw system
5) Tower and foundatation
6) Power and control system



Rotor

Rotor is the unique component among other components grouping. Other types of machinery may have drive train, brakes, gearbox, generator but only wind turbines have rotors designed to extract energy from the wind and convert it to rotary motion.

The function of the rotor is to convert part of the power contained in the wind stream in to mechanical power in the rotor shaft.

It includes several sub system and comprises all turning parts outside the nacelle. The subsystems of the rotor are

Blades
Hub
Blade Pitch mechanism

Rotor Blades

It captures the kinetic energy available in the wind and transfers it power (Torque) to the hub as forces and moments.

FRP

Fiber reinforced composite materials are currently for wind turbine blade manufacturing.

Three Different Fiber materials are available

Glass fiber
Carbon fiber
Organic aramid fiber (KEVLAR)

Fiber Glass

Strength properties are extraordinary high.
But it'S specific modulus of elasticity is not so good.

Carbon Fiber

It has longest tearing strength as well as high modulus of elasticity.
Stiffness is comparable to the steel
Fatigue properties are good.

Hub

It connects the blade to the main shaft and ultimately to the rest of the drive train. The hub transmits and must withstand all the loads generated by the blades. The forces and moments on the rotor blades are transferred to the low speed shaft through the hub connections and the hub.

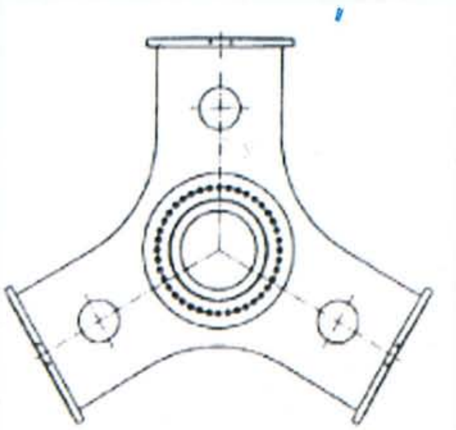
Hubs are generally made of steel either welded or casting

Types

1.Rigid
2.Teetering hub
3.Hubs for hinged blades

Rigid hubs

Rigid hub is directly coupled to the main shaft and rotates along with the main shaft.



Teetering Hubs

This means that the hubs mounted on the bearings. Teetering hubs are used in nearly all two bladed Wind turbines. This is because teetering hub can reduce loads due to the dynamic imbalance.

An advantage of teetering rotor is that the bending moment in the blades can be very low during normal operation.

Hinges on the Hub

This type of hub also mounted on the two bladed wind turbines. Hinges allow the blades to move into and out of plane of rotation independently of each other.

Drive train
It consists of all rotating parts from the rotor hub to the electrical generator. These Components form a functional unit and therefore always be considered together. The mechanical drive train and the electrical system are generally accommodated inside a closed nacelle. The nacelle must also house the yaw system.

A complete Wind turbine drive train consists of all the rotating components such as

- Main shaft
- Main bearing
- Coupling
- Gear box
- Brake system
- Flexible coupling
- Generator

Shaft
Shafts are cylindrical or conical elements designed to transfer torque. Their primary functions are normally to transmit torque and so they carry (or) are attached to the gears, pulleys or couplings. In wind turbine shafts are typically found in gearboxes, generators and in linkages.

Main shaft
In this rotor is bolted to a very strong disc (Hub) . Main shaft is the principal-rotating element provides for the transfer of torque from the rotor to the rest of drive train. It also supports the weight of the rotor.

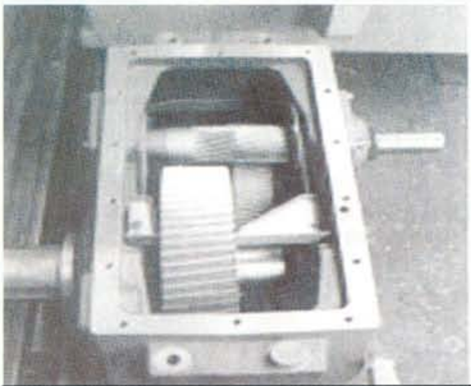
The gearbox is placed at the other end of the main shaft.

Gear box
There are lots of gearings in the gearbox. The function of gearbox is to increase the speed of the output shaft to the generator. An increase in speed is needed because wind turbine rotors and hence, main shafts turn at a much lower speed than is required by most electrical generators. Some gearboxes also perform functions other than increasing speed, such as supports the main shaft bearing. The rotor speed will be stepped up to the synchronous speed of the generator.

Types of gears
All gearboxes have some similarities, may consist primarily of a case, shafts, gearings, gear bearings and seals. Beyond that, they are two types of gearbox used in wind turbines

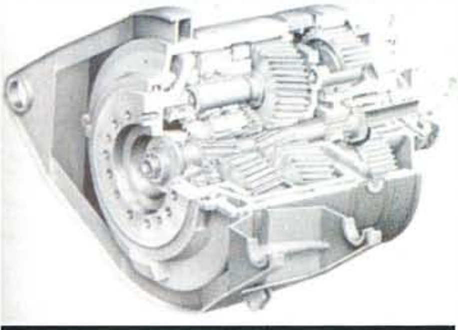
- Parallel shaft gearbox.
- Planetary gearbox.

Parallel Shaft Gear Boxes
In parallel shaft gearboxes, gears are carried on two or more parallel shafts. These shafts are supported by bearing mounted in the case. One of them is connected to the main shaft and other to the generator. Two gears are different size.



Parallel shaft gearbox

Planetary Gear Boxes
Have a number of significant differences from parallel shaft gearboxes. Most notable, the input and output shafts are co-axial. In addition there are multiple pairs of gear teeth meshing at anytime, so loads on each gear reduced. This takes planetary gearboxes relatively light and compact.
In large wind turbine, the planetary design definitely prevails. For outputs of several megawatts two (or) three-stage models are used.



Planetary gearbox

Brake
All wind turbines employ a mechanical brake somewhere on the drive train. Such a brake is normally included in addition to any aerodynamic brakes. Current design standards require two independent brakes system, one of which is usually aerodynamic and other of which is on the drive train.

Types of brakes (Mechanical)
- Disk Brakes
- Clutch Brakes

Disk Brakes
Disk Brake is a device for slowing or stopping the rotation of the rotor. It is usually made up of cast Iron. To stop the wheel, friction material in the form of brake pad (mounted in a device called a caliper) is forced mechanically, hydraulically on pneumatically against of the disk. Friction causes the disc and attached wheel to slow or stop. Operates in a manner similar to that on an Automobile.

A steel disk is rigidly affixed to the shaft to be parked. During braking hydraulically actuated calipers pushes brake pads against disk. The resulting force creates a torque opposing the motion of the disk thus slows the rotor.

Clutch Brakes

Actuation of clutch brakes is normally a spring. These brakes are released by compressed air (or) hydraulic fluid.

Aerodynamic Brakes System

Stall controlled wind turbine usually incorporate aerodynamic brake.

Tip brake
Flaps (or) Spoilers.

The presence of aerodynamic brakes for over speed control is an indispensable feature of a rotor with fine blades. In wind turbines, turnable rotor tips (or) spoilers are used, which are retracted in to the blade profile during operation.

The tip brakes are activated by a loss of hydraulic pressure in the case of emergency (or) for rotor shutdown.

Tip brake is described for use on the blade of a wind generator so that the tip will be rotated relative to the remainder of the blade to slow the rotation of the rotor. The tip of the blade is rotatable, about its longitudinal axis, with respect to the remainder of the blade. A brake mechanism interconnects the blade tip with the remainder of the blade to cause the blade tip to be rotated when the blade is subjected to a predetermined amount of centrifugal force. Once the blade tip has been deployed to slow rotation of the rotor, it will remain deployed until the wind becomes very low or the rotor is manually slowed so that the spring can cause the tip to be reset.

Spoilers

In order to reduce lift it generates, intentionally deployed to create carefully controlled stall over part of a blade.

Coupling

Couplings are elements used for connecting two shafts together for the purpose of transmitting torque between them. A typical use of coupling in WT is the connection between the generator and the high-speed shaft of the gearbox.

Genarators

All grids connected wind turbine drive three phase alternating current generators to convert mechanical energy in to electrical energy.

Types of generator

Synchronous generator
Asynchronous Generator

A synchronous generator or alternator operates at exactly the same frequency as the network to which it is connects. An asynchronous generator or induction generator operates at slightly higher frequency than the network. Both types of stator are connected to the network and have three phases winding on a laminated core: they produce magnetic field rotating at constant speed. Synchronous generator has a field winding through which DC current is fed through. The field winding creates a constant magnetic field, which locks in to the rotating filed created by the stator winding. Thus the rotor always rotates at a constant speed in synchronism with the stator field and network frequency

The rotor of an induction generator is quite different .It consists of squirrel cage of bars, short-circuited at each end. There is no electrical connection to the rotor, and the rotor currents are induced by the relative motion of the rotor against the rotating field of the stator. If the rotor speed is exactly equal to the speed of the rotating field produced by the stator there is no relative motion, no induced current. Therefore induction generator always operates at a speed is slightly higher than speed of rotating filed.

The speed of the asynchronous generator will vary with the turning force (moment, or torque) applied to it. In practice, the difference between the rotational speed at peak power and at idle is very small, about 1 per cent. This difference in per cent of the synchronous speed is called the generator's slip.

Naclle cover and Mainframe

The nacelle cover is the wind turbine housing protects turbine components from atmospheric weather conditions and it reduces emitted mechanical sound. It is made up of FRP material.

The main frame supports the heavy machinery/Drive trains and transmitting the load to the tower via yaw mechanism.

Yaw system

A horizontal axis wind turbine has a yaw system which is able to align the Nacelle in such a way that turns the nacelle according to the actual wind direction, using a rotary actuator engaging on a gear ring at the top of the tower. Yaw drive used for rotate the nacelle with respect to the tower on its slew bearing .Yaw system keeps the turbine facing in the wind

Tower

Tower is one of the main components of the horizontal axis wind turbine's support structure. It raises turbine up in the air.

Types of Tower.

Lattice Tower.
Tubular Tower
Concrete Tower

Most modern medium sized wind turbines have tubular towers, which allow access from inside the tower to the nacelle during bad weather conditions. The tower must be designed to withstand wind loads and gravity loads and live loads.. The nacelle is place on the top of the tower through yaw bearing

Electronic Controller

Consists of number of micro computers or micro processors, which monitor the condition of the wind turbine and collect statistics on its operation, manage and optimize turbine operation. They maximize power generation under varying conditions and they mange the generation units interconnections to the power grid. Protecting turbine components at high wind speeds. It controls large number of switches, hydraulic pumps and motors with in the wind turbine. Controllers check the rotational speed of the rotor, gear, generator etc,.

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Www.windenergy.org

K.Boopathy,
Scientist, R&D, C-WET

EVALUATION OF TEST SITE FOR PROVISIONAL TYPE TESTING AS PER THE RECOMMENDATIONS OF IEC 61400-12-1.

Introduction

The Provisional Type Testing of wind turbines is being conducted at WTTS as well as field sites as per the recommendations of relevant IEC standards. The following tests are being conducted as per the Type Approval Provisional Scheme (TAPS-2000).

1 Power Performance measurements
2 Safety and Function testing
3 Yaw Efficiency
4 Load measurements

At this point of time the Provisional Type Testing of wind turbines is being conducted at WTTS and at field sites under Category II/III of the Certification Scheme.

Assessment of the site

The site conditions of terrain, environmental and electrical grid should be favorable in order to carry out the above mentioned tests as per the recommendations of the International Standards. The sites proposed by the customer shall be assessed based on the following information provided by the customer and the methodology recommended in the relevant standard.

Information to be provided by the customer

- Customer shall make available a 1:50000 contour map (20 m contour interval) with the proposed test site clearly marked on it. Type tests will not be conducted in semi complex and complex terrains (slopes in any direction greater than 10 % up to a distance of 8L where L=2.25D0.25 and D is the rotor diameter of the test turbine.
- 1 m contour map of the area around the proposed location of the test turbine up to a distance of 8L where L=2.25D0.25 and D is the rotor diameter of the test turbine)

The contour map should have a scale of 1:1 and in *.dwg/ *.dxf format

- The contour map shall clearly indicate any significant objects in the area such as other wind turbines, proposed wind turbines, belonging to any developer including those of the customer, transmission towers, vegetation, hutments, plantations etc. These objects shall be drawn to scale. A table providing details including height, and width of objects shall be provided Photographs for eight azimuth directions should also be included

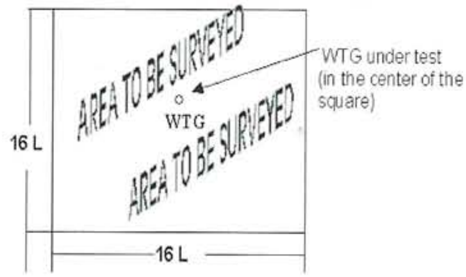

Figure 3.2.1 Area to be covered for contour mapL=2.25D0.25 where D is the rotor

- Time series wind data from the proposed site at least for one year should be made available. If the measurement site is different, a contour map (survey of India map of 1:50000) with 20 m contour interval should be supplied with the exact location of the wind mast and the proposed test turbine site clearly marked. In no case data from more than 10 km in level terrain and 3 km in case of semi complex terrain will be acceptable.

- Extreme climatology at the proposed locations as per IS 875 part III.

• Evaluation methodology.

C-WET on receipt of the proposal will carry out the following

Evaluation of the information provided by the customer.

Measurement Sector

The measurement sector shall exclude directions having significant obstacles, significant variations in topography or other wind turbines, as seen from both the test turbine and the meteorological mast. The elimination methodology shall be as per the recommendations of IEC 61400-12-1. However the recommendation does not indicate any absolute sector and this has to be determined from the data of the wind direction and the proposed period of measurements.

Terrain Slopes

The slopes of the terrain shall be evaluated and compared at L,2L,4L and 8L from the 1 m contour map with the recommended slopes in the standard given in the following table

Distance	Sector	Maximum Slope %	Maximum terrain variation from plane
<2 L	360	<3*	<0.04(H+D)
2 L and < 4 L	Measurement sector	<5*	<0.08(H+D)
2 L and < 4 L	Outside measurement sector	<10*	*Not applicable
4 L and < 8 L	Measurement secto	r<10*	<0.13(H+D)

* The maximum slope of the plane, which provides the best fit to the sectoral terrain and passes through the tower base.
** The line of steepest slope that connects the tower base to individual terrain points within the sector. **H- Hub height** **D- Rotor Diameter**

The slopes of the terrain determined in a simple or a complex terrain will give an indication for the position of the mast. However further analysis may be required during the site visit for positioning the meteorological mast.

Site visit of the proposed locations

During the site visit by the testing unit of C-WET the following activities shall be carried out.

- Verification of the obstacles and terrain conditions as per the map.
- Finalization of the position of the meteorological mast
- Finalization of the sector for measurements considering the final position of the mast.
- Information from the customer regarding the following critical local issues, which shall be verified at the site.
- Land availability for met mast
- Grid availability
- Security issues for the data acquisition equipment

Selection of most feasible location for testing

The proposed site shall be selected provided it conforms to the recommendations of the IEC 61400-12-1 regarding measurement sector and terrain conditions. Also the viability of measurements at the location in respect to the above mentioned critical local conditions shall be studied and finalized.

The feasibility of using the proposed site shall be reported

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