INTRODUCTION OF THE INDIAN WIND ENERGY SECTOR

Dr S Gomathinayagam
Executive Director,Centre for Wind Energy Technology, Chennai-600
Email: ed@cwet.res.in

GENERAL: Indian Energy Industries have an installed capacity of 150 GW of Electricity generation as on date, of which 14 GW is from all Renewable Energy Sources in which about 10.3 GW is from Wind Energy. Wind is one of the fastest and most viable Renewable energy technologies. In India, the annual capacity addition per year is currently about 1700MW. India also has about 1MW of wind solar hybrid domestic system which are mostly used as standalone applications. So in what follows you will be seeing a brief introduction to the wind energy sector in India.

WIND ENERGY IN INDIA: India ranks 5th in Wind power generation as on date, with US having the highest installed capacity of over 25GW, with Germany, Spain, China following with 24,17 and 12 GW respectively. In the Indian wind power development, the primary driving factor has been feed in tariffs (FIT) and accelerated depreciation and other tax incentives for domestic wind systems. Hence most of the investors in Wind Energy, apart from the demonstration projects of State and Central Governments are all from the

TABLE 1: STATE WISE WIND POWER INSTALLED CAPACITY *(Ref)*

State	(MW)	% (MW)
Tamil Nadu	4305	42.0
Maharastra	1939	18.9
Gujarat	1567	15.3
Karnataka	1327	13.0
Rajasthan	73.8	7.2
Madhya Pradesh	213	2.1
Andhra Pradesh	123	1.2
Kerala	27	0.3
West Bengal	1	0.0
Others	3	0.0
Total	10242	100.0

Private Sector. Today there are more than 3500 wind farm owners having capacities of WEG (Wind Electric Generator) from 225 kW to 2000 kW and most of the owners have bought either from Vendors (system integrators) or manufacturers having joint ventures or licensing agreement with Foreign collaborators mostly of European origin. State-wise installed capacity is given in Table-1

India has got an ambitious plan to exploit in full, the wind energy potential in the Country which is estimated to be 48 GW of which only 20% has been exploited as on date. However, this amounts to about 3 to 5% of net electricity generated in India.

POWER AND ENERGY IN THE WIND: It is well known that wind is certainly an inexhaustible abundant source of energy which is caused by the differential solar radiation on the Earth's geo-diverse surfaces, having different degrees of absorption/reflection/refraction/convection/transmission. Wind power is not only a renewable green source of energy; but also results in significant saving of potable/drinking water, which is much needed for human survival. Electricity generation by wind consumes only $(1/200)^{th}$ *to* $(1/400)^{th}$ of water that is used by nuclear/oil/coal. We understand the wind as breeze (gentle/comfortable), a force to reckon with at times of design of structures, a power to harness through wind machines and a brute force/power to be resisted during cyclones/hurricanes. We need to be clear that a Country with a long coast line need not necessarily be having economic/technical potential for wind power with its diurnal variations of land breeze/sea breeze. At the other extreme the mere occurrence of good monsoon or frequency of cyclones & hurricanes may not provide an economical viability, a technical feasibility of wind power. When wind (i.e. velocity 'U') is a resource, it has a force proportional to square of wind velocity (U^2), the power proportional to cube of wind velocity (U^3).

WIND TURBINE MANUFACTURERS IN INDIA: There are more than 12 manufacturers of Wind Turbines which are grid connected to State Electricity Boards. Most of the manufacturer's facilities are in Pune, Ahmedabad, Chennai and Puducherry. The technology has been steadily improving which has resulted in the cost reduction of more than 8 times in the last 3 decades i.e. from 40 cents (US $)in 1980s to about 3-4 cents (US $) in 2009. This has given rise to several new entrants in the MW Class wind turbines in India.

Some of the names along with the foreign collaborators are listed in Table -2

TABLE 2: WIND TURBINE MANUFACTURERS IN INDIA *(Ref)*

Company	Foreign Collaborator
Elecon Engineering Co Ltd	Turbowinds, Belgium
Enercon (India) Ltd	Enercon, Germany
GE Wind Energy India Ltd *	GE, USA
Ghodawat Energy Ltd	AMSC-Wintec, Austria
Hansen drives Ltd **	Hansen, Belgium
Kenersys India Pvt Ltd	Kenersys, Germany
Lietner Shriram Manufacturing Ltd	Leitner Technologies, Italy
LM Glasfiber India Pvt Ltd ***	LM Glasfiber, Denmark
Pioneer Windcon Pvt Ltd	...
Regen Powertech Pvt Ltd	Vensys, Germany
RRB Energy Pvt Ltd	...
Southern Windfarms Ltd	...
Suzlon Energy Ltd	...
Vestas Wind Technology Pvt Ltd	Vestas, Denmark
WinWind Power Energy (P) Ltd	WinWinD, Finland
*Yet to start operations, ** gearboxes *** only blades	
Note: Collaborator is financial or technical, list is indicative	

While Suzlon Energy is the largest manufacturer in India, it is World's 5th leading player in WEGs. Apart from meeting the Indian WEG-market, for several manufactures it is also an export opportunity. It seems around 8000 crores worth WEGs made in India are exported abroad.

WIND ENERGY PROJECT DEVELOPMENT: Wind energy development in India has been initiated by the demonstration projects established by Government of India in highly windy areas. Steps to follow for a wind power project are as follows:

- Wind Resource Assessment through measurements, micro surveying and potential site identification
- Choice of the capacity and the number of the wind turbines for the identified sites for wind farming

- Micrositing of the wind turbines in a particular wind farm
- Erection and commissioning of wind turbines
- Establishment of continuous monitoring systems like SCADA
- Grid connection of wind turbines
- Power quality measurements and feed back
- Wind resource prediction/forecasting and load scheduling to load demand & Generation Management
- Power trading options across inter-state boundaries

TECHNOLOGY OPTIONS: Wind energy development has by nature, is a merger of several inter-disciplinary subjects starting with meteorology, environment, mechanical composites, electrical systems and electronic controls along with the civil engineering requirements for the foundation and the tower structure.

Here, the Rotor which converts the kinetic energy in wind to mechanical energy has a possible efficiency level of 45-55%. Theoretically, it can go up to 59% which is known as BETZ's limit and the rotatory energy is then converted to mechanical energy through a system of gears to make the low rotation into higher rotation to interface with the generator. Most of these gear systems have been designed with an efficiency of 92-97% in the highly matured industry, which is manufacturing the mechanical components. From the gear system it goes to the generator which converts the mechanical energy to electrical energy where the high level of efficiency has been established in the industry to the tune of 90-95%. So in a sense, technology option in the first phase of kinetic to mechanical energy has been shifting from constant speed rotor to variable speed rotor all over the world. The variable speed rotor is of capable capturing about 15 to 20% more energy from the turbulent wind. The mechanical system which has also been seeing several advancements in terms of geared, direct drive and gearless machines is still banking on proven technology for cost effectiveness. If there is gear system, it is interfacing the rotor with a low speed shaft and the generator with a high speed shaft. The latter is to generate power to match with the constant frequency and voltage of electric grids viz. Utilities.

Conversion of mechanical to electrical energy through the generators is also going through several advancements in technology in the recent years. From traditional squirrel cage induction generators which convert AC-AC as the wind varies has been shifting to synchronised AC-DC-AC type of generators for efficient power capture from the wind. In

the aero dynamic controls, the shift is taking place from traditional stall control to pitch control and modern machines have active controls independently for stall as well as pitch mechanism. These sophisticated active controls require power electronics and hydraulics interfacing with various systems. Some of the latest WEGs use electro-magnetic/mechanical control systems instead of hydraulics. The modern machines manufactured in India with foreign collaboration have capacities more than 1 MW and they are highly suited for a tropical Country like India.

In general, India has more than 59 wind electric generator models manufactured by several manufacturers, some of whom have stopped business and some of them have newly entered into business with latest models. In effect there are only 11 to 12 manufacturers who are actively involved in Grid connected WEG development in India.

ROLE OF C-WET IN WIND POWER DEVELOPMENT IN INDIA: As earlier mentioned, C-WET is an Autonomous R&D Organisation, established under the Ministry of New and Renewable Energy and it has enabled orderly wind power development in India. It has been the only reliable source quite some time for the assessment of wind energy potential in India. It offers value added services in terms of identification of potential windy sites and project planning, Micrositing and due diligence studies in the area of wind resource assessment. Its services are utilised by Private, Public and Government agencies equally. C-WET has an International standard Test Station at Kayathar close to Kanyakumari which can test wind turbines from 225 kW to MW class machines. Wind turbine type testing is an accredited service under NABL certification and it is recognised in more than 52 Countries in the World today and C-WET is striving to get MEASNET (A high quality measurement network of institutions based in Europe/Germany who carry out wind turbine testing and measurement for technical excellence) membership which will give C-WET India the global recognition. C-WET also ensures the quality of the machines which are connected to Indian power utilities to protect the investors as well as manufacturers utilities equally. C-WET follows IEC:WT-01 standards and carries out the type certification of wind turbines under a scheme called TAPS 2000 which has been customised for Indian conditions with the help and guidance of experts from RISO/Denmark which follows several standards which are currently in vogue in the Indian Wind Industry.

C-WET also coordinates with several academic institutions, National Research Laboratories and private companies independently in Research and Development in the area of wind energy to facilitate cost reduction in wind electric generation. C-WET assists the regulatory

body which is the Central Electricity Regulatory Authority (CERC) in technical matters on policy and regulatory issues. It does the design evaluation for the purpose of certification of assessing the various models which are being offered by several manufacturers in Indian market following International standards. C-WET releases a list of models of manufacturers which is called RLMM (Revised List of Models & Manufacturers) every quarterly which is referred by the Electricity Boards for enabling the grid connection to power utility services, of the WEG models.

C-WET also undertakes Human Resource development suitable to the Indian Wind Energy Industry by conducting National and International Training Programmes. Since this is an area of multi disciplinary nature, academicians & industry and Scientists of C-WET join hand together to complete the training programmes.

THE NATIONAL POLICY AND REGULATORY INTITIATIVES: The Government of India, in association with the manufacturers IWTMA (Indian Wind Turbine Manufactures Association) IWPA (Indian Wind Power Association) and InWEA (Indian Wind Energy Association) has discussed several aspects to promote wind energy in India. The recent initiative by the Government of India are more towards generation based incentive for the wind farm developers and energy by repowering of wind farms which are having old and low capacity machines and also it has a policy to give open access and power trading including inter state trading facilities for wind. In some states in India, even net metering concepts practiced in USA & Europe for small/domestic wind turbines, for wind solar hybrid systems are already in place. There are IPP (Independent Power Producers) enablers who manage establishment of Wind Power projects with CDM (Clean Development Mechanism) benefits of Carbon Credits.

FUTURE INDIAN SCENARIO:

Issues in Wind Power Developments: Availability of accurate wind potential data all over India is one of the issues. C-WET has assessed more than 620 Stations spread all over the Country by continuous monitoring of wind as a resource and identified more than 216 locations as economically viable and wind potential. As on date, in India a site which has more than 200 watts per square meter as Wind Power Density (WPD) is declared economically viable. With recently picked up micro wind generation i.e to exploit urban wind areas and low wind areas and to facilitate remote village electrification domestic wind

mills of .3 kW to 30 kW are being adopted. This micro wind generation as on date has a low market demand since it has been mostly developed as a standalone system which is often not grid connected. The grid interface system which will have similar concepts such as net metering along with exporting to grid and importing from the grid in a house connection is likely to be possible soon. It has fast track implementation of wind power projects given by Government having fiscal and financial initiative. India is likely to penetrate the wind as a green power upto 10% of electricity generation of the Nation, with the highly supportive Governmental policies.

The major issue of utilisation of wind power has been the infirmity of the wind. This can be overcome the current sophisticated technology to forecast wind enabling load scheduling to meet the load demand and generation gap.

Innovative approach to Operation and Maintenance "O&M", is now being implemented using Central Monitoring systems and SCADA type continuous monitoring with remote controls.

Another important issue in the Indian wind power development is development of infrastructure facility in wind farmable areas such as roads and logistics for larger machine components to reach windy Regions. Other infrastructural facilities for establishment of human habitation wind farm and establishment of electrical grid for evacuation of the power generated by the wind turbines. Most of the State and Central Government have been concentrating on these infrastructural developments and hence wind power in India has become more viable and the growth is sustained at the global rate of more than 20% every year. Table 3 gives a few keys for sustaining this 20% wind power growth in India.

Ref:

Key Reference to statistics :- Shri Venugopal Pillai,"Revolution in the Air", Electrical Monitor,October 2009,PP. 30-37

TABLE 3: WIND POWER INDUSTRY TRENDS

AREA	CURRENT STATUS	DESIRED CHANGE
Resource	Gross-potential	Microzonation for accuracy
Private investments	Tax/incentive driven	CDM/generation/green Energy/Quality
Manufacturing	From foreign IPRs/DWG	Indigenous Design capability
Competition	Cut-throat	Open-Consortium
Health-monitoring	minimal	Learn from failures
R&D & innovation	In closed doors	A consortium and industry supported
Small Wind Turbines & Hybrid (Wind+Solar)	Small alone battery charger type	Net metering with Grid interactive/interfaced
Grid Code	Not mandatory	May be practiced to ensure power quality/stability of Grids