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The Wind Power Industry : An Overview, Major Issues and Strategies Adopted with Specific Reference to India

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Abstract - With the increase in awareness about protecting our environment and the support for the cause by all major economies of the world through the Kyoto Protocol, the importance of wind power has grown in stature since it is clean and the most viable renewable energy resource. The global annual market of new wind turbine installation is more than US\$ 40 billion at current prices, considering world-wide installations of about 40000 MW annually. This paper reviews the growth of the wind power industry globally as well as in India. The opportunities for investment in this industry and problems associated with it are also discussed with specific reference to India. In the second part of this paper, the business model of two of the major wind turbine manufacturers of India, Suzlon Energy Limited, and Enercon India Limited are discussed and their strategies are compared.

I. INTRODUCTION

Growing concern for the environmental degradation and fast depletion of fossil fuels has led to the world's interest in non-polluting and renewable energy resources. Wind is commercially and operationally the most viable renewable energy resource and accordingly, emerging as one of the largest source in terms of the renewable energy sector. The technology of wind power, both on-shore and off-shore installations, has seen continuous development since the last two decades. Commercially viable wind energy converters of various capacities, Kilowatt to Megawatt class, have proved to be able substitutes for the conventional sources of power.

II. LITERATURE REVIEW:

Global Wind Power Industry – An Overview :

The global wind power industry has been for the past several years dominated by three major markets – western Europe, North America (USA and Canada), and Asia (China and India). While these three markets still accounted for more than 90% of total installed capacity at the end of 2011, there are signs that this may be changing. Emerging markets in Latin America, Asia and Africa are reaching critical mass and there may be more of them rising to challenge the three main markets in the coming years. Commercial wind farms now operate in close to 80 countries, and present many benefits for both developed and developing countries – increased energy

security; stable power prices; economic development which both attracts investment and creates jobs; reduced dependence on imported fuels; improved air quality; and, of course, Carbon dioxide emission reduction. Each of these factors is a driver in different measure in different locations, but in an increasing number of countries they combine to make wind power the generation technology of choice (GWEC 2010, 3).

New Installations and Growth of this Sector Globally:

The total wind power installations world wide as on end 2011 was 238351 MW. The region-wise data is shown in Table No. 1 with details of those countries having wind power installations of a minimum of 3500 MW as on end 2011 (GWEC 2011, 2).

Table No. 1: Region & major country wise wind power installations				
Region	Country	New installations in CY 2011 (MW)	Cum. MW as on end CY 2011	
Africa & Middle East		31		1093
Asia		21298		82398
	China	18000	62733	
	India	3019	16084	
	Others	279	3581	

Europe			10281		96616
	Germany	2086		29060	
	Spain	1050		21674	
	Italy	950		6747	
	France	830		6800	
	UK	1293		6540	
	Denmark	178		3871	
	Portugal	377		4083	
	Others	3518		17843	
Latin America & Caribbean			1206		3203
North America			8077		52184
	USA	6810		46919	
	Canada	1267		5265	
Pacific Region			342		2858
Total World-wide			41236		238351
<i>Source: Global Wind Statistics 2011, GWEC</i>					

Table No. 2 indicates the data of new installations in the major countries the world over from 2006 to 2010. The growth of wind power capacity during each of the last five years on a world-wide basis has been at least 22% on year-on-year basis except for 2010, when negative growth was observed (GWEC reports). However, the high growth countries have been few. During the last five years, China has at least doubled its capacity every year except for 2010 when it grew at 64%, which is still far greater than any of the other countries having appreciable wind power installations. This has made China the world leader in terms of MW of installations as on end 2010, ahead of the USA, to which it has held on even as on end 2011. India, which is in the fifth position based on wind power capacity as on end 2011, has grown at a rate between 20% and 27% year-on-year, except for 2009 when it grew at 13%. During the last three years, capacity growth of Germany and Denmark has been in single digit and that of Spain between 8% and 15%. Italy, France and the UK have grown between 20% and 39% on a year-on-year basis. The USA and Canada have consistently grown at a good pace of more than 40% for the USA and 26% to 40% for Canada, except for the USA in 2010 and 2011.

Table No. 2: Region, major country & year wise wind power installations										
Reg- ion	Country	New installations during the CY year (MW)								
		2006		2007		2008		2009		2010
Africa & Middle East		172		160		130		230		213
Asia		3679		5226		8579		15442		19022
	China	1840		3304		6300		13803		16500
	India	1347		1575		1800		1271		2139
	Others	492		347		479		368		383
Europe		7708		8662		8877		10526		9883
	Germany	2233		1667		1665		1917		1493
	Spain	1587		3522		1609		2459		1516
	Italy	417		603		1010		1114		948
	France	810		888		950		1088		1086
	UK	634		427		836		1077		962
	Denmark	12		3		77		334		327
	Portugal	694		434		712		643		345
	Others	1321		1118		2018		1894		3206
Latin America & Caribbean		295		30		95		622		703
North America		3230		5630		8884		10946		5805
	USA	2454		5244		8358		9996		5115
	Canada	776		386		526		950		690
Pacific Region		888		158		486		577		176
Total World-wide		15196		19866		27051		38343		35802
Source: Global Wind Energy 2006/2007/2008/2009/2010 Reports										

Major Issues with Global Wind Power Industry:

Wind turbine generators have very low operating costs, but the initial investment is very high. This makes the wind power sector vulnerable to the nuances of a fluctuating economy. Till the end of 2008, when the global economy was going strong, there were no barriers to the growth of this sector. However, due to the meltdown of the developed economies like the US and the Euro zone, the impact of which was felt in almost rest of the world including India, new project financing started getting affected with many planned wind power investments getting postponed during this cash-crunch period. But even during this crisis period, the support of all major Governments for green wind power was always there. Now with the global economies back on the road to recovery, new investments into this sector are coming back slowly but surely.

The capital cost of producing wind turbines has fallen steadily over the past 20 years as turbine design has been largely concentrated on the three-bladed upwind model with variable speed and pitch blade regulation. Manufacturing techniques have been optimized, and mass production and automation have resulted in economies of scale (GWEC 2010, 11). The electricity generated by wind is still more expensive than power obtained from conventional power plants, unless the environmental benefits of wind power are taken into account. If the cost of wind energy could be reduced by an additional 30–50%, then it would be globally competitive. The goal of achieving this reduction has inspired designers to seek cost reduction by increasing the size, tailoring of turbines for specific sites, exploring new structural dynamic concepts, developing custom generators, and power electronics, in addition to implementing modern control-system strategies (Orosa 2010, 25–28).

Indian Wind Power Industry – An Overview:

India has been an attractive location for wind turbine manufacturers. This is because of the following major reasons which are critical to this business – The Indian wind power market has been consistently growing at more than 20% every year; the Indian economy proved to be very strong with a solid foundation by quickly recovering from the shock of the global meltdown, thus increasing the investors' confidence; the quality of Indian human resource has proved its mettle right from the years the IT industry started taking shape, thus increasing the industry's confidence on its capability; the cost of manufacturing in emerging economies like India is lower due to lower labour costs and easy availability of manpower, which off-sets the higher productivity due to greater process mechanization adopted in developed economies; certain

Government incentives also make India an attractive location for manufacture of wind turbines both for the Indian markets as well as for exports.

Most of the major wind turbine manufacturers in India are either Multi-National Companies (MNCs) / wholly-owned subsidiaries of MNCs like Vestas Wind Technologies India Private Limited, or Gamesa Wind Turbines Private Limited, or an Indian firm having a joint venture / collaboration / agreement / licence with a foreign company for design and technology of the wind turbine like Enercon India Limited which uses the Enercon GmbH design, ReGen Powertech Private Limited which uses the Vensys design, or Leitner Shriram Manufacturing Limited which uses the Leitwind BV design. However, wind turbine manufacturers like Suzlon Energy Limited and Kenersys India Private Limited manufacture as per their own design.

Wind in India is influenced by the strong south-west summer monsoon, which starts in May-June, when cool, humid air moves towards the land and the weaker north-east winter monsoon, which starts in October, when cool, dry air moves towards the ocean. During the period March to August, the winds are uniformly strong over the whole Indian Peninsula, except the eastern peninsular coast. Wind speeds during the period November to March are relatively weak, though higher winds are available during a part of the period on the Tamil Nadu coastline (www.inwea.org).

A notable feature of the Indian wind power programme has been the interest among private investors / developers in setting up of commercial wind power projects. The gross potential is 48,561 MW (CWET), the state-wise break-up of which is indicated in Table No. 3 (GWEC 2009, 7).

Table No. 3: State-wise Wind Energy Potential in India (Source: C-WET)

State	Potential (MW)
Andhra Pradesh	8968
Gujarat	10645
Karnataka	11531
Kerala	1171
Madhya Pradesh	1019
Maharashtra	4584
Orissa	255
Rajasthan	4858
Tamil Nadu	5530
Total	48561

However, the current figures are based on measurements from only nine states, and which were taken at low hub heights, in line with old technology. A more recent wind atlas published by the Center for Wind Technology (CWET) in April 2010 estimated the resource potential at 49130 MW. This was based on an assumed land availability of 2% and 9 MW of installable wind power capacity per square kilometer. It seems likely that the wind power potential is considerably underestimated. The Indian Wind Turbine Manufacturers Association (IWTMA) estimates that at hub heights of 55 – 65 meters, potential for wind development in India is around 65 – 70 GW. The World Institute for Sustainable Energy, India (WISE) considers that with larger turbines, greater land availability and expanded resource exploration, the potential could be as great as 100 GW (GWEC 2010, 30). Moreover, the above estimates are only for on-shore turbines.

India began wind power development in the 1990s. But it has only begun to take off in the last few years. Although a relative newcomer to the wind industry compared to Denmark or the US, a combination of domestic policy support for wind power and the rise of a

leading global wind turbine manufacturer have led India to become the country with the 5th largest installed wind power capacity in the world, and one of the wind energy leaders in the developing world (Lewis 2007, 5).

New Wind Turbine Installations and Growth of this Sector in India:

India had an installed wind capacity of 14158 MW as on end March 2011, which had increased to 16084 MW by the end of the year 2011. However, wind power in India is concentrated in a few regions, especially the southern state of Tamil Nadu, which maintains its position as the state with the largest wind power installations. It had 5.9 GW installed on end March 2011, representing close to 40% of India's total wind capacity. The state-wise wind power installation data is shown in Table No. 4. This is beginning to change as other states, including Maharashtra, Gujarat, Rajasthan, Karnataka, West Bengal, Madhya Pradesh and Andhra Pradesh start to catch up, partly driven by new policy measures (GWEC 2010, 30).

State	March 2011	March 2010	March 2009	March 2008	March 2007	March 2006	March 2005
Tamil Nadu	5904.4	4907	4304.5	3873.4	3492.7	2894.6	2037
Karnataka	1730	1473	1327.4	1011.4	821.1	584.5	410.7
Maharashtra	2310.8	2078	1938.9	1755.9	1487.7	1001.3	456.2
Rajasthan	1524.8	1088	738.4	538.8	469.8	358.1	284.8
Andhra Pradesh	200.2	236	122.5	122.5	122.5	121.1	120.6
Madhya Pradesh	275.5	229	212.8	187.7	57.3	40.3	28.9
Kerala	32.8	28	27.0	10.5	2	2	2
Gujarat	2175.5	1864	1566.5	1252.9	636.6	338	253
Others	0	4	1.1	1.1	1.1	1.1	1.1
Total	14158	11807	10242.3	8754.0	7090.8	5341	3594.3

Policy Environment in India for Wind Energy and Major Issues pertaining to this Sector:

India has been an active supporter of wind power development since the 1990s, and has a government ministry exclusively devoted to renewable energy promotion, i.e., the Ministry for Non-conventional Energy Sources. However, India's policy support has been somewhat unstable over the years, which led to uneven wind development in the 1990s. Problems with inaccurate wind resource data, poor installation practices

and poor power plant performance also slowed early wind power development in India (Lewis 2007, 5).

The Ministry of New and Renewable Energy is the nodal ministry for development of all renewable forms of energy including wind energy (www.inwea.org). The central government has put in place a set of fiscal and promotional incentives like generation-based incentives of Rs. 0.50/kWh, concessional import duty on specified wind turbine parts, 80% accelerated depreciation in the first year, Excise duty relief, loans through IREDA, and

income tax holiday applicable to wind power as in the case of power projects.

The national generation-based incentive (GBI) scheme for grid connected wind power projects, for the cumulative capacity of 4000 MW to be commissioned by March 2012 was announced in December 2009 by India's Ministry of New and Renewable Energy (MNRE). The GBI scheme provides an incentive of 0.5 Rupees per KWh (0.8 Euro cents) in addition to the existing state feed-in tariff. Investors who because of their small size or lack of tax liability cannot benefit from accelerated depreciation under the Income Tax Act can opt for this alternative incentive instead, up to end March 2012 or before the introduction of a new Direct Tax Code, whichever is earlier. After this date, the accelerated depreciation may be phased out. This should facilitate the entry of large independent power producers into the wind market, attract foreign direct investment and level the playing field between different types of investors. In addition, since this incentive is based on actual electricity production, rather than installation, it stimulates higher efficiencies. However, for India to reach its potential and to boost the necessary investment in renewable energy, it will be essential to introduce clear, stable and long-term support policies, carefully designed to ensure that they operate in harmony with existing state level mechanisms and do not reduce their effectiveness (GWEC 2010, 31).

A prominent issue connected with new wind power projects is the availability of land for installation of wind turbines. This is because, in some of the states with good wind-mapped zones, people do not prefer to part with their land for such installations.

Financial viability of a wind power project also depends on the existence / non-existence of power evacuation infrastructure in the near vicinity and technical capability of the available nearby infrastructure to take the power generated from the wind farm. Availability of grid at wind farm site has always been a major constraint as the generation points are generally far off from load centers (www.cercind.gov.in).

A factor which is specific to the developing countries including India is the preference for the sub-megawatt class wind turbines. This is mainly because of two reasons – the total capital investment required for the project is lesser compared to larger machines; and there is limited infrastructure available in such countries for transporting, handling, and installing the bigger wind turbines.

The evolution of the wind power industry has followed a steady path during the last ten years when it first started with the smaller machines, and then slowly

graduating to the megawatt class. Now manufacturers are in to the multi-megawatt class with Kenersys India Private Limited, Inox Wind Limited already putting up 2 MW wind turbines in India, so are others like Leitner Shriram Manufacturing Limited, and Gamesa Wind Turbines Private Limited with plans in place for 2 MW and above capacity wind turbines. The initial installations in the prime wind zones have been the smaller capacity machines. Thus, even though the wind turbines have grown in size, yet the land available in terms of the wind quality for the turbines is inferior. The strategy adopted to lessen this problem is repowering where, in good wind zones, the smaller capacity wind turbines are replaced with the larger ones so that the total installed capacity of the wind farm increases, reduces operating costs, and improves load factors and power grid integration.

Manufacturer-wise Wind Turbine Installations in India:

The manufacturer-wise installation of wind turbines in India during the year 2009-10 is shown in Table No. 5. Based on these data, the top 5 wind turbine manufacturers accounted for 90% of the installations in MW. Suzlon Energy Limited with almost 49% market share was the leader, Enercon India Limited was in 2nd position with 22%, and together they accounted for more than 70% of new installations in India.

Sl. No.	Name of Manufacturer	MW Installed in India during the Year 2009-10
1	Suzlon Energy Limited	762.65
2	Enercon India Limited	348.80
3	Vestas Wind Tech India Pvt Ltd	121.95
4	RRB Energy Limited	119.25
5	ReGen Powertech Pvt Ltd	55.50
6	Pioneer Wincon Pvt Ltd	27.00
7	Leitner Shriram Mfg Ltd	21.00
8	Southern Windfarms Limited	18.00
9	Global Wind Power Ltd	16.50
10	Sinovel Wind (China)	15.00
11	Shriram EPC	14.25
12	Gamesa Wind Turbines Pvt Ltd	13.60
13	WinWinD	10.00
14	Kenersys India Pvt Ltd	4.00
15	Godhawat Energy	3.30

16	Others	16.25
Total =		1567.05
(Source: www.windpowerindia.com)		

Leading Wind Turbine Manufacturers of India:

The next section of this paper briefly brings out the main details of the top two wind turbine manufacturers, i.e., Suzlon Energy Limited, and Enercon India Limited, in terms of new installations in India during the year 2009-10. Their strategies are also discussed and compared.

Suzlon Energy Limited:

Suzlon is the leading wind turbine manufacturer of India with presence in 21 countries. Its product portfolio consists of 2.1 MW, 1.5MW, 1.25 MW, and 600 KW wind turbine generators (www.suzlon.com). Suzlon is owned by a family that diversified into the wind energy business from the textile industry, incorporating the company in 1995. Within five years Suzlon had made the list of top ten wind companies, and it has remained there since (Lewis 2007, 6).

Not just an equipment supplier, Suzlon is also a full wind farm project developer and operator. Its varied services are offered by its associated company subsidiaries, which have also been established to cover specific regional markets. Suzlon's wholly-owned subsidiaries include technological development centers in Germany and the Netherlands, a rotor blade manufacturing company (Suzlon Energy B.V) in the Netherlands, a US market subsidiary (SWECO), and an Australian market subsidiary (Suzlon Energy Australia Pty Limited). In August 2004, Suzlon Energy A/S, a wholly-owned subsidiary, was created to supervise Suzlon's international marketing activities. A representative office in Beijing and a manufacturing facility in Tianjin have also been set up in China to expand Suzlon's presence in the Chinese market. In India, Suzlon has its manufacturing facilities at Daman, Chakan, Dhule, Gandhidham, Bhuj, Pondicherry, Coimbatore, and Padubidri. Thus, Suzlon currently has manufacturing facilities in four countries including India, China, USA, and Germany with an aggregate annual capacity of close to 15000 MW. Suzlon, through a company named SE Forge, has also establishing forging and foundry capacity at Coimbatore in India. It is also expanding its vendor base across countries to further improve supply chain efficiencies and to build a natural hedge against foreign currency risks (www.suzlon.com).

Suzlon acquired a stake in REpower in May 2007. REpower is a recognized technology leader with a strong presence in Europe, and it controls approximately 10% of the German market share. REpower

manufactures medium to high capacity wind turbine generators (WTG) of capacities from 1.5 to 5 MW. This acquisition gives Suzlon the advantage of complementary geographical presence, product portfolio, supply chain strategies, and REpower's off-shore leadership. Together with its subsidiary REpower, Suzlon has grown to be the 3rd largest wind turbine supplier in the world (www.suzlon.com).

In May 2006, Suzlon completed the acquisition of Hansen Transmissions International NV, Belgium, the world's second largest gearbox manufacturer for wind turbine generators (www.suzlon.com). Hansen Transmissions is a technology leader in making gearboxes for wind turbines, and brings a market advantage, being a supplier to leading wind turbine manufacturers.

Suzlon's business has dramatically grown with strategic alliances and acquisitions, as well as new green-field manufacturing facilities as part of its strategy of vertical integration whereby building in-house capabilities and capacities for all the key components of its wind turbine generators.

Thus, the strategy of Suzlon has been to build in-house capabilities for the major portion of all the critical components so that it is not dependent on sub-contractors for volumes and quality. Though this has increased the company's investments, but it has lent a degree of stability to its delivery targets.

Enercon India Limited:

Enercon India Limited is one of the main players in the Indian wind power industry and was formed as a joint venture of Enercon GmbH, Germany and its Indian promoters, the Mehra Group. This ISO 9001-2000 certified company commenced commercial operations in 1995 and produces the 800KW wind energy converter, which is considered to be one of the most popular machines in India in the Kilowatt class. This machine is of gearless construction and operates at a continuous variable speed synchronous with the varying wind speeds. It has the ability to withstand voltage fluctuations of + 20% of nominal voltage and has a wide frequency operation band of 46 – 54 Hz. Enercon has designed Hub and Blades such that the weight of the Hub Rotor is much lower than that of other manufacturers; hence, the initial moment of inertia is low. Due to this and pitch regulation feature the machine starts generating power at low wind speed i.e., 2.5 m/s whereas other machines start at 3.5 to 4.5 m/s. Therefore, at lower wind speeds, Enercon wind energy converters have an advantage of generating higher energy than that of other manufacturers (www.enerconindia.net).

Enercon offers a truly valued service from concept to commissioning and even more. It takes up selection of site, micro-siting plan, acquisition of land, all Government clearances, assisting in getting finance, supplying, installation and commissioning of the Project, operation of the wind farm, and also offers unique comprehensive Operation and Maintenance package which includes spares, consumables and any break-down maintenance at a fixed O&M price (www.enerconindia.net).

Enercon India Limited manufactures wind energy converter of only one size and design, i.e., the 800 KW machine, and installs them only in the Indian market as per its existing agreement with Enercon GmbH. Since this size is in the popular range for the Indian market, and as this wind turbine is envisaged by the market as an efficient machine, its popularity has remained unabated. Its installations in India during the FY 2009-10 was 436 nos. of 800 KW machines amounting to 348.80 MW, with cumulative installations of 2357.59 MW till end March 2010. Thus Enercon India Limited was the 2nd largest wind power company of India after Suzlon Energy Limited, based on cumulative installations in the country as on end March 2010 (www.windpowerindia.com).

Enercon India has its own blade manufacturing unit at Daman along with the wind turbine assembly units. For all the components, it has developed suppliers both in India and abroad. It relies on a strong supply chain team which has developed multiple sources for all the components like castings, generators, bearings, fabricated rotor and stator carriers, towers etc.

III. DISCUSSIONS AND CONCLUSION:

With the depletion of fossil fuels and the adverse effect of such fuels on the environment, the support for renewable energy has grown by the day with the Governments of all the major economies providing installation and generation based incentives. Wind power being the major source of clean and green power, has seen the maximum growth in this sector world over.

The major markets of wind power business have been China and India in Asia, USA and Canada in North America, and Western European countries like Germany, Spain, Italy, France, UK, Denmark and Portugal.

Due to techno-economic reasons, India has become a manufacturing hub for the wind power sector with all major wind turbine players putting up manufacturing facilities in India. In terms of new installations in India during the year 2009-10, Suzlon Energy Limited and Enercon India Limited were the two major

manufacturers with installations of 762.65 MW and 348.70 MW, respectively.

Though both these companies are into the same business of manufacture and installation of wind turbines, and development of wind farms, yet they are different in many ways. Suzlon Energy Limited is an Indian company, which is listed in the Indian Stock Exchanges, while Enercon India Limited, which is a joint venture of Enercon GmbH, Germany and Indian promoters the Mehra Group, is a Private Limited company. Suzlon's product portfolio consists of 2.1 MW, 1.5 MW, 1.25 MW and 600 KW machines, all of which are with-gear designs, while Enercon India's only product is the 800 KW gearless wind turbine generators.

Since the growth forecasts of this business have been strong at least for the next decade, both Suzlon and Enercon India have separate strategies in place to take the maximum benefit out of this. In order to have better control on the deliveries of different critical components as well as to control costs, Suzlon has adopted the vertical integration strategy by either setting up green-field manufacturing facilities, or acquiring different critical component manufacturers and technology providers so as to have complete control over the supply chain. On the other hand, Enercon India has gone for a lean structure by sourcing all components, except for the blades, from multiple sources that are developed by their supply chain team so that the entire critical quality requirements as well as the delivery targets are met.

The technology of wind turbines is constantly improving. The size of the turbines has steadily increased. With the development of handling and allied infrastructure in India, the popularity of the megawatt and multi-megawatt class wind turbines is increasing. Even though India has a long coastline, the off-shore wind turbine technology is yet to come to India. However, with the strong growth forecasts for this sector and the Government incentives in place for clean power, off-shore wind power generation in India is not very far-off.

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