International Journal of Enhanced Research in Science Technology & Engineering, ISSN: 2319-7463
Vol. 2 Issue 12, December-2013, Impact Factor: 1.252, pp: (132-138), Available online at: **www.erpublications.com**

Repowering Potential of Wind Farm in India

Dr. Rohit Verma
Associate Professor, National Power Training Institute, Faridabad, Haryana, India

Abstract: **This document represent the powering potential need of wind farm in the Indian power sector. This is done by creating the repowering potential analysis for small and big size of the wind farm generator. The analysis was done based on the key factor associated with feed-in-tariff and also the regulation of Indian. The need of new policy is required for making the repowering easy and makes the growth in the prompt rate with the world power market. The policy regulation and law has to be made by the Indian government to support the wind farm generator and attract the developer in this area.**

Keywords: Renewable energy, Wind farm, Feed-in-tariff, reliability, CAGR, Repowering.

I. INTRODUCTION

The Global Wind energy market witnessed huge growth from 2009 to 2010 as total wind power capacity grew by 22.3%. The global wind energy installed capacity increased at a compound annual growth rate of approximately 27.9 %. Power expansion has come increasingly from the urgent need to combat global climate change. Wind-power penetration in many cases faces significant barriers due to limited transmission capability [6]. Wind generation is one of the most mature and cost-effective resources among different renewable energy technologies. Due to the utility deregulation, more generators from independent power producers (IPPs) have been proposed in recent years [1]. Improving economic, environmental benefits, supportive state policies, and the rising costs of competing fuels are all contributing factors towards greater market interest in wind energy [2]. A key question is how the variations in wind plant outputs affect the operation of the power system on a daily basis with variable demand and what the associated costs are [3].

India wind energy sector has shown the potential growth in the Area concerned for the repowering as it has lost the rating in total installed capacity in comparison to china. Due to this in the last two years the installation capacity is decreasing [4]. Investments into the sector have increased significantly to development of the wind energy market.

The share of renewable energy was 7.7% in the cumulative installed capacity in MW. In India as per the Indian government by 2012 expects renewable energy to contribute 10% of the total power generation capacity and have 4%–5% share in total electricity Generation. It is estimated that 6,000 MW of additional wind power capacity will be installed in India by 2012.

As per the report of global data the wind market repowering installed capacity grew by 2499,4 MW in the 2011. And the compound annual growth rate (CAGR) is estimated of 23.3 %. The market across the world seems tremendous growth for the re-powering of wind farm. The strong economic growth expected in near future calls for substantial addition to India's Generating capacity. Fossil fuels and hydro-electricity will continue to play a dominant role in the energy sector of the country in the next few decades.

As per the wind farm industry growth the older technology replace the newer technology and big size machines replace the new small size machine this will lead to development of the technology trends. For the same the integration of the plant unit is required [5]. How wind technology has advanced over the years is the repowering of the world's first wind turbines in Altamont Pass, California is a kind of example.

Non-renewable, fossil fuel resources therefore need to be used prudently. Being limited and non-renewable, fossil fuel resources therefore need to be used prudently. Use of fossil fuels also leads to environmental problems such as global warming and climate change. At, the same time the existing technologies of production, transmission and distribution of electricity as well as end-use have inherent inefficiencies. It is, therefore, imperative to diversify the country's energy supply [13].

In the year 2011, the installations capacity of India's to just over 16,000 MW. Now in year 2011 the capacity addition is estimated 3000 MW. As per the growth plan capacity may go up to 5000 MW per year by 2015. The prompt efforts make by Indian government to create new policies will attract large no of private player to enter in this sector [7].

II. Repowering Potential

Repowering is the process of replacing older, smaller wind turbines with modern and more powerful machines, which would reap considerably more power from the same site [8]. In India, about 46% of the WTGs were rated below 500 kW in 2010, adding up to 2,331.3 MW (about 18% of cumulative installed capacity). A special drive for repowering of old wind farms undertaken by the central government would encourage the industry. To take this up on a larger scale. This could be done by way of creating suitable mechanisms and offering support along with financial incentives, to make new repowering projects viable.

A. Why Repowering

Many of the states facing power shortages are also host to sites with good wind power potential which is not being used efficiently and is currently saddled with old and inefficient wind turbines. Repowering with more powerful turbines would bring considerable benefits. Large areas are occupied by more than 8,500 small rating turbines (<500 kW capacity), manufactured by suppliers that have long since disappeared from the Indian market (as of March 2009). This leads to lapses in operations & maintenance, which in turn increases machines down time, reduces revenue & maintenance costs tend to be higher for aging WTGs.

Breakdown of critical components badly affects machine availability and O&M cost for smaller capacity machines. The operation and maintenance cost of wind turbine are to be done based on the discount rates [8].

Old wind turbines were often installed at maximum hub-heights of 30 to 40 meters and occupy land on good resource sites. However, these sites could benefit from modern turbines extracting energy from the much higher wind power density at high hub heights.

B. Challenges for Repowering

- Turbine ownership: Repowering will reduce the number of turbines and there may not be one-to-one replacement. Thus, the issue of ownership needs to be handled carefully.
- Land ownership: Multiple owners of wind farm land may create complications.
- Power Purchase Agreement: PPAs were signed with the state utility for 10, 13 or 20 years and the respective electricity board may not be interested in discontinuing or revising the PPA before its stipulated time.
- Electricity evacuation facilities: The current grid facilities are designed to support present generation capacities and may require augmentation and upgrading.
- Additional costs: The additional decommissioning costs for old need to be assessed.
- Disposal of old turbines: There are various options such as scrapping, buy–back by the government or manufacturer, or export. Local capacity may need to be developed.
- Incentives: One of the primary barriers to repowering is the general lack of economic incentive to replace the older WTGs. In order to compensate for the additional cost of repowering, appropriate incentives are necessary.
- Policy package: A new policy package should be developed which would cover additional project cost and add-on tariff by the State Electricity Regulatory Commissions (SERCs) and include a repowering incentive (on the lines of the recently introduced generation-based incentive scheme by MNRE) [9].

III. REGULATION LAW & FEED IN TARIFF

A. National renewable energy law in India

While the policy environment for wind power in India has improved in recent years, the industry is still heavily dependent on tax incentives that tend to attract a narrow range of investors. In addition, the Indian power sector is plagued with inefficiencies and severe reliability problems that create a difficult environment for wind power growth. Understanding of the wind repowering for the market is the potential sources of the country and probably the most important requirement for India is an integrated framework that has a vision, a plan and an implementing mandate that supports the RE policies and regulations from the conceptual to the implementation stage. Today, most leading countries with strong wind power development have this framework in place in the form of a renewable energy law and make the wind power repowering is the most substantial sources. With this the plant integration for the wind zones and smaller size unit empowered and make repower the wind farm [6]. Such a framework, if adopted, can help to reduce concerns of investors related to long term regulatory certainty and associated market risks.

Table 1: Comparison of State level wind power development in India

	STATES								
	Particulars	Andhra Pradesh	Gujarat	Karnataka	Kerala	Madhya Pradesh	Maharashtra	Rajasthan	Tamil Nadu
1	Total number ofidentified sites	32	40	26	17	7	39	8	45
2	Identified number ofpotential districts	7	9	9	3	5	13	5	11
3	Annual meanwind speed(m/sec) at 50 m mast height	4.86-6.61	4.33-6.61	5.19–8.37	4.41–8.12	5.0–6.25	4.31–6.58	4.02–5.73	4.47–7.32
4	Number of wind monitoring stations established till October 2010	63	69	49	27	37	112	36	68
5	Number of wind monitoring stations operating (as of December 2010)	2	6	5	-	4	22	1	1
6	Installablewind potential (MW)	5,394	10,609	8,591	790	920	5,439	5,005	5,374
7	Presently installed capacity(MW) till Dec. 2010	176.8	2,005.30	1,576.20	28	230.8	2,201.60	1,353.40	5,502.90
8	Untapped installablepotential (MW) as in Dec. 2010	5,217.20	8,603.80	7,014.90	762	689.2	3,237.40	3,671.70	-128.9*

B. State Feed-in Tariff

In June 2008 the government declared the generation based incentives scheme [8]. At present thirteen SERCs have declared preferential feed–in tariffs for purchase of electricity generated from wind power projects established in respective states. All the SERCs have adopted a ‘cost plus’ methodology to fix the feed–in tariff, which varies across the states depending upon the state resources, project cost and other tariff computing parameters as considered by the respective SERCs.

The national feed in tariff incentives decided by MNRE will generate the notional change in the generative incentives. In the table-2 the details of feed-in-tariff for different states are given.

Table- 2: Feed-in-tariff

States	Tariff rates per kWh	Annual tariff escalation	% Renewable Portfolio Standard for wind
Andhra Pradesh	Rs. 3.50	Constant for 10 years for the PPAs to be signed during 01-05-09 to 31-03-2014	5% for all RE (2011/12)
Gujarat**	Rs. 3.56	No escalation for 25 years of project life	5% (2011/12) 5.5% (2012/13)
Haryana	Rs. 4.08	With 1.5% per year till 5th year	10% (2010/11) for all RE
Karnataka*	Rs. 3.70	No escalation for 10 years	7-10% (2010/11) for all RE
Kerala	Rs. 3.64	No escalation for 20 years of project life	3% (2011/12 & 2012/13) for RE
Madhya Pradesh**	Rs. 4.35	No escalation for 25 years of project life	6% (2011/12)
Maharashtra	Wind Zone I–Rs. 5.07	No escalation for 13 years	7% (2011/12) 8% (2012/13) for all RE
	Wind Zone II–Rs. 4.41		
	Wind Zone III–Rs. 3.75		
	Wind Zone IV–Rs. 3.38		
Orissa	Rs. 5.31	No escalation for 13 years	5% for all RE (2011/12)
Punjab	Rs. 3.49	With base year 2006/07 & with 5 annual escalations @ 5% up to 2011/12	4% for all RE (2011/12)
Rajasthan**	Rs. 3.87 & Rs. 4.08	No escalation for 25 years of project life Rs. 3.87/kWh for Jaisalmer, Jodhpur & Barmer districts while Rs. 4.08/kWh for other districts	7.5% (2011/12)
Tamil Nadu	Rs. 3.39	No escalation for 20 years of project life	14% for all RE (2010/11)
Uttarakhand	Wind Zone II–Rs. 5.15*	Rs. 5.65 for 1st 10 year & Rs. 3.45 for 11th year onward	4.53% for all RE (2011/12)
	Wind Zone III–Rs. 4.35*	Rs. 4.75 for 1st 10 year & Rs. 3.00 for 11th year onward	
	Wind Zone IV–Rs. 3.65*	Rs. 3.95 for 1st 10 year & Rs. 2.55 for 11th year onward	
	Wind Zone I–Rs. 3.20*	Rs. 3.45 for 1st 10 year & Rs.2.30 for 11th year onward	
West Bengal*	Rs. 4.87	No escalation for10 years	3% for all RE (2011/12)

Table-3 Type of Incentives available under SERC's

SCHEME	INCENTIVES
Feed-in tariff	• 13 SERCs have declared preferential feed-in tariff for purchase of electricity generated from wind power projects established in respective states. • All the 13 SERCs have adopted cost plus methodology to fix the tariff which varies across the states depending up on the state resources.
Renewable Purchase Specifications	• 26 SERCs have specified the mandatory purchase obligation under Section 86, 1(e) of the Electricity ACT, 2003, for purchase of fixed percentage of energy generated from RE sources. • The RPS percentage varies from 0.5% to 14%, depending on the local renewable resources and the electricity distributed in that area. • RPS obligation can be fulfilled trough tradable REC mechanism which can further generate revenue for wind power projects. The state-wise RPS percentage is analyzed and shown in
Grid connectivity	• As per the Electricity Act, 2003, the respective State Transmission Utility (STU) is responsible for creation of grid Interconnection infrastructure for connectivity up to the proposed wind farm at its own cost. However, with present poor financial health of these STUs and the time required to create such infrastructure, states adopt different practices for creation of the required infrastructure.

IV. POLICY DIRECTION

A. Need of Policy Initiatives

The stage for wind energy development was set with the government announcing fiscal incentives in the form of 100 percent accelerated depreciation benefits and customs duty exemption on the import of certain components. While these fiscal incentives were successful in promoting wind energy development, the main purpose of generating power through wind got relegated to the background [11]. Such projects were mostly viewed as financial undertakings, having little or nothing to do with the power generation per se. Things since have changed with the policy focus shifting from capacity addition to generation Technology with respect to change in over voltage form for the entire wind project [10].

For the American power market, the most important federal subsidy for wind power is the renewable energy production tax credit ("PTC"), which provides a tax credit for electricity generated by wind plants for a period of ten years from initial plant operation. Evidence suggests that wind energy production is tied directly to the availability of this tax credit. PTC was extended to run through 2013.

Table 3: Average size of WTG (Kw) Installed each year

	Years					
Country	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
China	771	897	931	1,079	1,220	1,360
Denmark	2,225	1,381	1,875	850	2,277	2,368
Germany	1,175	1,634	1,848	1,879	1,916	1,977
India	**767**	**780**	**926**	**986**	**999**	**1,117**
Spain	1,123	1,105	1,469	1,648	1,837	1,897
Sweden	1,336	1,126	1,138	1,670	1,738	1,974
UK	1,695	2,172	1,953	2,049	2,256	2,251
USA	1,309	1,466	1,667	1,669	1,677	1,731

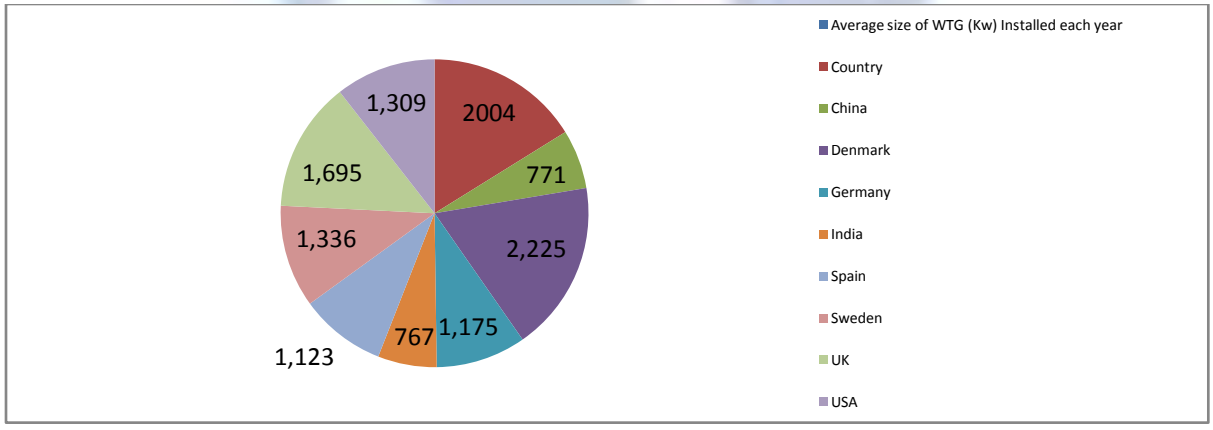

Fig. 1: Size of Wind Turbine in KW

B. Government Initiatives for Re-Powering

So, while government incentives have driven the wind industry in India till now, new market realities are emerging. The advert of IPP's, larger-sized projects, non-resource financing, repowering and offshore wind farms all point to the beginning of new chapter in the wind power market in India[11].

Table 4: Wind Generation Capacity factors in key states

	Gujarat		Karnataka		Maharashtra		Tamil Nadu	
	Generation (MU)	**Capacity Factor %**	**Generation (MU)**	**Capacity Factor %**	**Generation (MU)**	**Capacity Factor %**	**Generation (MU)**	**Capacity Factor %**
2001	142.23	9/73	72.26	22.36	142.58	15.23	1,095.84	16.01
2002	134.76	9.22	92.86	20.91	332.75	15.69	1,245.76	17.26
2003	147.34	9.99	175.11	24.20	666.63	19.04	1,305.50	16.73
2004	138.30	8.76	308.16	24.17	643.17	18.23	1,592.63	16.78
2005	224.97	11.96	778.60	34.24	688.90	18.74	2,113.65	15.77
2006	264.07	10.98	1,113.82	28.0	790.00	24.98	3,845.80	19.50
2007	303.18	8.24	1,449.05	25.42	1,714.00	19.37	5,301.01	19.93
2008	987.47	13.85	1,505.78	19.22	1,804.00	8.97	6,065.86	19.47
2009	2,104.00	18.02	1,723.00	17.78	2,207.00	13.98	6,206.00	17.91
2010	2,988.00	20.782	2687.00	22.42	2,625.00	15.19	8,146.00	20.96

No doubt, challenges of land acquisition, local clearances and grid integration exist, but the winds of change are certainly blowing which improves the not only the repowering but also improves the reliability of the system [14].

VI. CONCLUSION

Harnessing and using renewable energy is an important way that the India can reduce its dependence on foreign oil and slow the pace of global warming. Repowering of the wind farm will lead to India as a emerging wind power generator in the world power map. The design and technology trend for the repowering and reliability increasingly very fast , for making the same pace government should support for the new initiatives and make more power producer to enter in the wind farm. Once the repowering potential potential is indentified then only the development will support the wind farm reliability.

References

[1]. J. Kabouris and C.D. Vournas, 'Application of Interruptible Contracts to Increase Wind Power Penetration in Congested Area', IEEE Trans on Power Systems, Vol. 19, No. 3, pp- 1642-1649, August 2004.
[2]. C. Chompoo-inwai, W.J. Lee, P Fuangfoo, M. Williams and J.R. Liao, 'System Impact Study for the interconnection of Wind Generation and Utility System', IEEE Trans on Industry Application, Vol. 41, No. 1, pp. 163-168, January/February 2005.
[3]. R. Piwko, D Osborn, R Gramlich, G Jordan, D Hawkins and K Porter, 'Wind energy delivery issues', IEEE Power & Energy Magazine, Vol.3, No.6, pp.47-56, November/December 2005.
[4]. Mohit Goyal "Repowering--Next big thing in India" Renewable and Sustainable Energy Reviews, 2010, vol. 14, issue 5, pages 1400-1409.
[5]. E. A. DeMeo, W Grant, MR. Milligan and M.J. Schuerger, 'Wind plant intergration: Cost, Status & Issues', IEEE Power & Energy Magazine, Vol.3, No.6, pp.38-46, November/December 2005.
[6]. Aswini Kumar Dash1 & Biswajit Das2" The Wind Power Industry: An Overview, Major Issues and Strategies Adopted with Specific Reference to India" Special Issue of International Journal of Power System Operation and Energy Management, ISSN (PRINT): 2231 – 4407, Volume - 1, Issue-3.
[7]. Global Wind Statistics 2011, Global Wind Energy Council, February 2012, pp 2.
[8]. Indian Wind Energy Outlook 2009, Global Wind Energy Council, September 2009.
[9]. Ministry of New and Renewable Energy, Government of India, (2009) New Delhi, http://www.mnes.nic.in.
[10]. C. Feltes, S. Engelhardt, J. Fortmann, F. Koch, I. Erlich ", High Voltage Ride-Through of DFIG-based Wind Turbines" 2008 IEEE.
[11]. Km. Saroj Gupta (Research scholar) "Sustainable wind energy system: Role of Energy policy and security-A case study from India" Journal of Economics and Sustainable Development www.iiste.org.
[12]. Ministry of Power, Government of India, New Delhi (2009) www.powermin.nic.in.
[13]. IEA, Deploying Renewable: Principles for Effective Policies, International Energy Agency (IEA), Paris, 2008.
[14]. Amit Jain1*, R. Balasubramanian2, S.C. Tripathy "Reliability analysis of wind embedded power generation system for Indian Scenario" International Journal of Engineering, Science and Technology Vol. 3, No. 5, 2011, pp. 93-99.

Biographical notes

Dr. Rohit Verma has teaching, research and power industry experience spread over 20 years. He is a Associate Professor in the Centre for Advanced Management and Power Studies at National Power Training Institute, Faridabad and his research focuses on optimization of resources in energy sector. He started his career as an Asst. Engineer (O&M) in a coal based thermal power plants. He is a PhD from JMI University, Delhi. He received his B.Tech. in Mechanical Engineering and an M. Tech. in Energy and environment Management from IIT Delhi. He has been teaching the courses of Global Power Business, Power Station Management, Power Environment interface, Energy Resources & Power plant Systems and Renewable Energy. He has also authored books on Global Power Business, Renewable Energy and Operations Research. He has published 21 research papers in international/national journals and proceedings of international/national conferences.