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RE-Powering Potential of Indian Wind Farms:A Review

Neeraj Sen*, Siraj Ahmed, Atul Lanjewar*****

*Department of Mechanical Engineering,Maulana Azad National Institute of Technology,Bhopal MP, India
**Department of Mechanical Engineering,Maulana Azad National Institute of Technology,Bhopal,MP,India
***Department of Mechanical Engineering,Maulana Azad National Institute of Technology, Bhopal, MP, India

Abstract

In India, history of wind energy has long time .Now this time ,the industry has made path breaking enrichment in turbines efficiency and relieability.Today we have turbines that offer a viable investment in low wind sites while also insuring improved relieability.Thus advancement in technology also offers another lucrative opportunity ,"Re-powering".Re-powering is the process of replacing the older ,smaller low output wind turbines .Re-powering is an investment option,In Germany and Denmark have favourable respons.In this paper re-powering potential of India is discussed with few case studies of India and foreign countries.

***Index Terms*-Re-powering,National,International experienc**

Introduction

Wind power has a major part to play in the development of renewable energy sources that is being pursued for energy and environmental policy reasons. The replacement of older wind turbines with new, high-performance turbines (repowering) is particularly important here. At the same time, repowering can also be used to reorganise wind-power locations in order to better integrate them into the planning of residential areas in municipalities.These informations contain basic information regarding the detailed of wind power and repowering.Repowering refers to the refurbishment of older turbines,this has generally been accomplished by installing fewer,larger turbines.

Repowering stands for replacement of old wind turbine with more powerful and modern turbines.This means able to generate more wind power from kisser surface area.Repowering as a concept is becoming an increasingly common feature in European markets,especially in Germany and Denmark. A pictorial representation of a repowered wind site is representatin in Fig. 1.

1.1 Need of Re-powering

1. Many of the states facing power shortage s are also host to site of good wind power potential which is not being used efficiently wind turbines.
2. Repowering with more powerful turbines would bring considerable benefits to these states
3. Large area is occupied by more than 8500 small wind turbine (<500kW capacity).
5. Maintenance costs tend to be higher for aging WTGs.
6. Breakdown the critical components badly affect the machine availability and O&M cost for smaller capacity turbine
7. Old wind turbines has maximum hub height 30 to 40 m occupied good resources sites.
8. Modern wind turbine extracting energy from higher wind power density at high hub height

Before Repowering

After Repowering

Fig.-1 Visual depiction of repowering

1.2 Key factor for Re-powering

Micro-siting and Wind study

Micro-siting is necessary for the optimisation of wind farm layout and locating new turbines as per the norms specified by respective state regulatory authorities. Since there would already be an existing wind farm, site prospecting is not an issue and it only needs to be validated with current wind/meteorological data to finalise the capacity and number of new wind turbine generators (WTG) that need to be replaced.

Micro-siting for a RePowering site would be a real challenge for the site personnel due to the presence of existing wind turbines in and around the site. Apart from maintaining the correct distance between the machines being proposed, it should be ensured that none of these machines violates the norms regarding inter-machine distance prevalent in the corresponding state. Any discrepancy in the micro-siting of the existing machines would adversely elect the micro-siting of the new wind turbines.

It is important to decide on the number and capacity of older machines to be removed as per the micro-siting details. Economic feasibility/viability is an important factor influencing the capacity and quantity of older machines to be removed based on the RePowering factor. Te removal of older running machines should be timed and planned properly to avoid any generation losses and at the same time,to not create any hindrance to the installation of new WTG.

Installation of New Turbines

It is essential to ensure that the installation of new wind turbines in the existing wind farms does not affect the operation of existing wind turbines and vice versa. It is also important to plan the project well in advance to ensure that access roads, platforms, storage area and removal/rerouting of the existing lines for moving new WTG components inside the wind farms is smooth and does not affect any wind turbines in the vicinity.

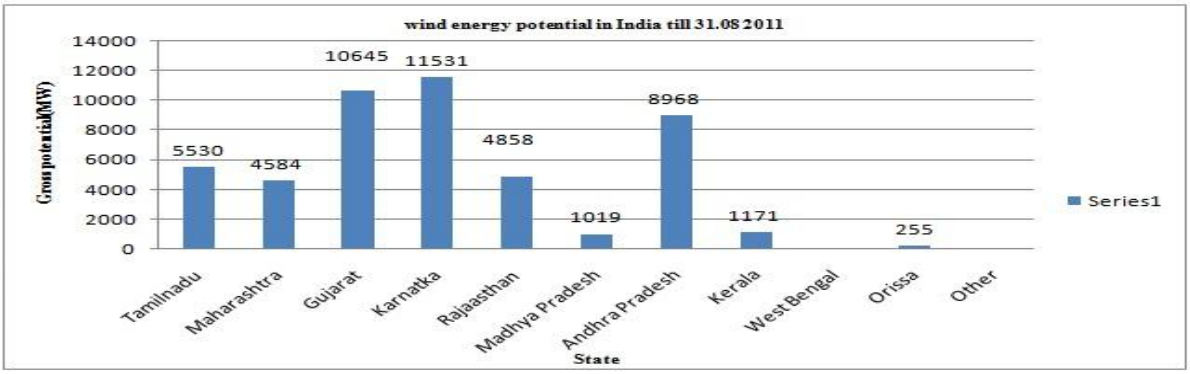

Fig.-2

Removal of Existing Turbines

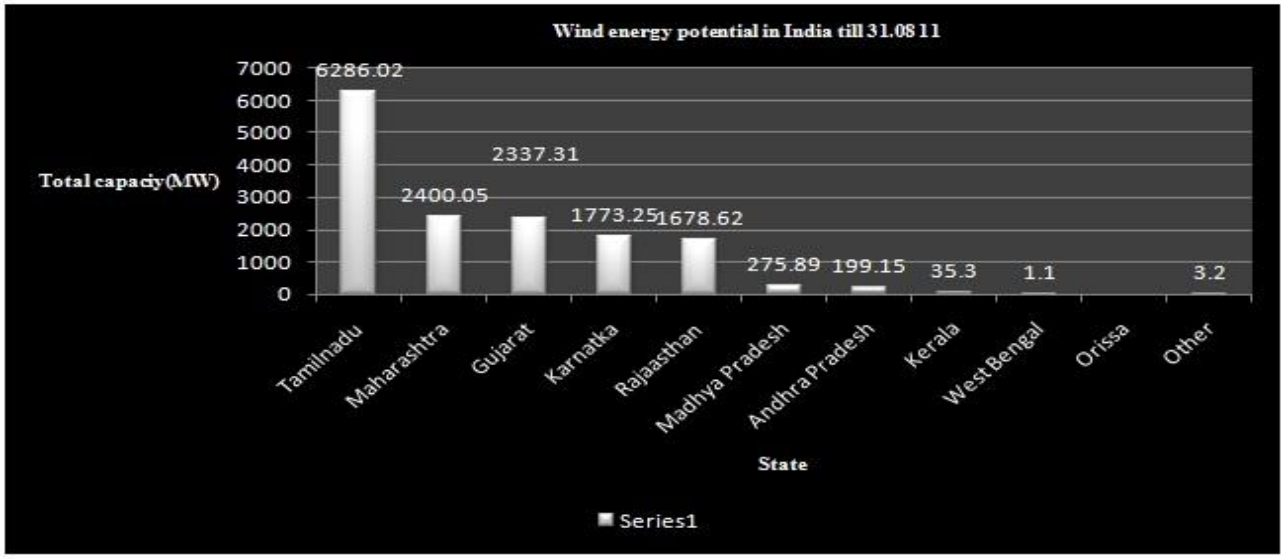
Wind energy potential in India till 31.08 11
Total capacity(MW)
7000
6000
5000
4000
3000
2000
1000
0
6286.02
2400.05
2337.31
1773.25
1678.62
275.89
199.15
35.3
1.1
3.2
Tamilnadu
Maharashtra
Gujarat
Karnatka
Rajaasthan
Madhya Pradesh
Andhra Pradesh
Kerala
West Bengal
Orissa
Other
State
Series1

Fig.-3

2.WIND ENERGY STATUS IN INDIA

The total potential for wind power in India was first estimated by the Centre for Wind Energy Technology (C-WET) at around 45 GW, and was recently increased to 49.13 GW[1,7]. This was adopted by the government as the official estimate. The C-WET study was based on a comprehensive wind mapping exercise initiated by MNRE, which established a country-wide network of 1050 wind monitoring and wind mapping stations in 25 Indian States. The assessment shows that India's total wind potential is 48,561 MW, with Karnataka, Gujarat, and Andhra radesh as the leading states up to 31st August 2011[2]. This effort made it possible to assess the national wind potential and identify suitable areas for harnessing wind power for commercial use, and 216 suitable sites have been identified.(Table 1) and fig.3 shows the wind energy potential and installation up to 31st August 2011 within India. However, the wind measurements were carried out at lower hub heights and did not take into account technological innovation and improvements and repowering of old turbines to replace them with bigger ones. At heights of 55–65 m, the Indian Wind Turbine Manufacturers Association (IWTMA) estimates that the potential for wind development in india 65-70 GW.Fig.1 and Fig.2 shows the gross potential and total capacity in different states in MW.

3. REPOWERING POTENTIAL IN INDIA

Repowering has enormous possibilities in India with more than 45,000 MW gross potential and 14,775MW technical potential estimated by Centre for Wind Energy Technology. While the total installed capacity for wind energy in India has increased significantly to about 14.55 GW as on March 2011 from 1,909 MW in March 2002, there is still huge potential left untapped across states with favourable wind characteristics. As of March 2011, only 32 percent of the total gross potential for wind power development has been installed in India.

Table 1
Wind energy potential in India according to C-WET

State	Gross potential (MW)	Total capacity (MW) till 31.08.11
Tamil Nadu	5530	6286.02
Maharashtra	4584	2400.05
Gujarat	10645	2337.31
Karnataka	11531	1773.25
Rajasthan	4858	1678.62
Madhya Pradesh	1019	275.89
Andhra Pradesh	8968	199.15
Kerala	1171	35.30
West Bengal		1.1
Orissa	255	
Other		3.2
Total	48561	14989.89

Source: *Infraline Energy Business Report*

The low utilization of the country's wind energy potential is attributable to several factors such as delay in acquiring land and obtaining statutory clearances, inadequate grid connectivity, and lack of appropriate regulatory framework to facilities purchase of renewable energy from outside the host state and high wheeling and open access charges in some of the states. Approximately 25 percent of turbines in India have rating below 500 kW, which gives tremendous repowering potential. Given the current situation, repowering as an investment option, which has already seen favorable response in countries like Germany and Denmark, would start maturing in India. (Table 2) lists down Re-powering potential across states(<500kW WTG installation):

S.No	State	Till 1997		After 1997	
		No. of WTG	Total capacity(MW)	No.of WTG	Total capacity(MW
1	Tamilnadu	1921	519.05	1368	343.27
2	Maharashtra	-	-	633	202.4
3	Gujarat	489	-	156	42.78
4	Andhra Pradesh	192	47.24	155	38.75
5	Karnatka	36	8.15	140	34.36
6	Madhya Pradesh	25	5.62	57	13.32
7	Rajasthan	-	-	63	19.41
	Total	2663	686.205	2572	694.29

Table 2

possible potential across states by taking into consideration only those farms which have at-least three or more WTGs and an installed capacity of less than 500kW per WEG and were commissioned till 1997 or have completed at least 15 years of operation. These projects can be taken up for repowering on priority till 2012. The varying plant-load factor for old projects, projects with PLF less than 13-14 percent can also be given priority.

Based on the above, the possible repowering potential and opportunities available across different states shown in table , which gives an overview of the major repowering opportunities across possible wind sites available in India(Table 3). This has been identified taking into consideration WTG installations till 1997 and only for those wind farms, which have multiple WTG's installed (>2). Based on this, as seen in the Table Tamilnadu has maximum repowering potential of about 519 MW, followed by Gujarat (72MW) and Andhra Pradesh (43 MW).

3.1.Wind Re-Powering Potential In Major States

Table 3

S.No.	State	Repowering opportunity in MW
1	Tamilnadu	519
2	Andhra Pradesh	47
3	Karnataka	8
4	Gujarat	106
5	Madhya Pradesh	6

Source:Infraline Energy Business Report

Repowering potential in Tamilnadu

Tamil Nadu has the highest wind installed capacity of 5,072.72 MW at the end of the July 2010 in India. The state has some of the world's best wind energy sites, including Muppandal, Tirunelveli, Chittipalayam, Kethanur, Gudimangalam, Poolavadi, Mrungappatti, Sunkaramudaku, KongalNagaram, Gomangalam and Anthir with average wind power density ranging between 200-25 W/sq.m. Tamil Nadu has a total wind farm re-powering capacity of 519.105 MW. Table gives the details of rat-

ing wise (below 500 kW) capacity installed in Tamil Nadu till 1997. WEG rating wise (less than 50 kW) installed capacity (MW) till in 1997

Table 4

S.No.	Rating	Installed capacity in MW
1	Upto 225 kW	146.5
2	226-250 kW	206.86
3	251-350 kW	33.63
4	350-410 kW	132.11

For re-powering Muppandal alone has wind farms capacity of 103.85 MW. Other than Muppandal, Poolawadi has 87.23 MW, Perungudi has 73.925 MW, Kethanur has 53.685 MW, Kayathar has 31.395 MW and Pazhavoor has 19.96 MW of wind farms re-powering potential. Table 3.4 gives an overview of the re-powering opportunities available at major windy locations in Tamil Nadu.

Major repowering opportunity in Tamilnadu

S.No.	Area	Installed capacity in MW	Repowering opportunity in MW
1	Muppandal	279.785	103.85
2	Poolawadi	180.715	87.23
3	Perundurai	107.53	73.985
4	Kethanur	105.43	53.685
5	Kayathar	81.74	31.395
6	Pazhavoor	140	20

Table 5

Re-powering potential in Gujarat

Gujarat is one of the leading states in India in wind power development. It has a total wind installed capacity of 2337.31MW as of 31.08. 2011. Ministry of New and Renewable Energy (MNRE) estimates a gross potential of 10,645 MW of wind power in the state.

Bhavnagar, Rajkot, Kutch and Jamnagar are the four major districts in Gujarat which are blessed with rich wind energy potential. Jamnagar and Rajkot are two district where wind farming started in early 1990s. Lamba, Dhank, Kalyanpur, Nevada and Pransla in the two districts provide an exciting opportunity for the investors to take up for repowering projects for the existing wind plants. Gujarat has a total wind farm re-powering capacity of 106.09 MW.

Dhank

Dhank is located in the Rajkot district of Gujarat and has a total wind energy installed capacity of 42.16 MW. Most of these turbines (40.17 MW) were commissioned before 1997 and can be re-powered with high capacity turbines.

Lamba

Lamba is located in the Jamnagar district with total wind energy installed capacity of 80.4 MW as on March 2010. Out of this around 30% (25.64 MW) of wind farms are available for re-powering under the above mentioned parameters.

Navadra

Navadra is located in the Jamnagar district of Gujarat and has a total wind energy installed capacity of 47.175 MW till March 2010.

Re-powering potential in other states

Andhra Pradesh

Wind energy development programme started in in early 1990s. The state has a total wind energy installed capacity of 199.15 MW as in 31.082011 with majority of the plants located in Ananthpur district.For re-powering, Andhra Pradesh has total wind farms capacity of 47.24 MW< which were commissioned before 1997 with wind turbine rating upto 250kW in Ananthpur district.

Madhya Pradesh

Madhya pradesh has a total installed capacity of 275.89 MW as in 31.08. 2011. The major wind energy hubs in the state of devas, ratlam and shajapur. Out of the total wind energy installed capacity, 5.62 MW wind farms in jamgodani in dewas district has the potential of repowering.

Karnataka

Karnataka too is a leading wind power developing state with a total installed capacity of 1773.25 MW as on 31.08.2011. However most of these wind mill farms have been developed after 1997. An opportunities arises for repowering 8.1 MW of wind farms owned by Jindal Aluminium Ltd.etc.Fig.4 (graphical presentation of re-powering potential and No of WTGs)

4. ADVANTAGES OF REPOWERING

Technical advantages

i. Efficient utilization of potential wind sites. producing high quantum of energy
ii. Improve Capacity Utilization Factor(CUF).

Operational Advantages

i. Repowering of wind farm reduce maintenance (O&M)cost.
ii. Modern wind farm offer better integration with grid ,which achieving a higher degree of utilization

Financial advantages

i. Achieving better wind power economics
ii. Repowering of wind farm result reduction of land area/MW of wind farm
iii. Repowering present an opportunity for states to achieve Renewable Purchase Obligation (RPO)targets and national targets in National Action Plan on Climate Change(NAPCC).
iv. It also offer Renewable Energy Certificate(RECs)
v. Clean development mechanism(CDM) benefits can maximized by reducing more green house gas(GHG)
vi. Foreign exchange can be generated from the project through the sale of certified emission reduction(CERs).

Social and environment advantages

i. Increase the visual appeal of the farm.
ii. Ring down the no of collision of birds
iii. Quality of land scope also improve as no of turbine are much less per unit area.
iv. Less noise pollution

5. CHALLENGES IN REPOWERING[9]

i. *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.
ii. *Land ownership*: Multiple owners of wind farm land may create complications for repowering projects.
iii. *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.
iv. *Electricity evacuation facilities:* The current grid facilities are designed to support present generation capacities and may require augmentation and upgrading.
v. Additional costs: The additional decommissioning costs for old turbines (such as transport charges) need to be
assessed.
vi. *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.
vii. *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.
viii. *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).

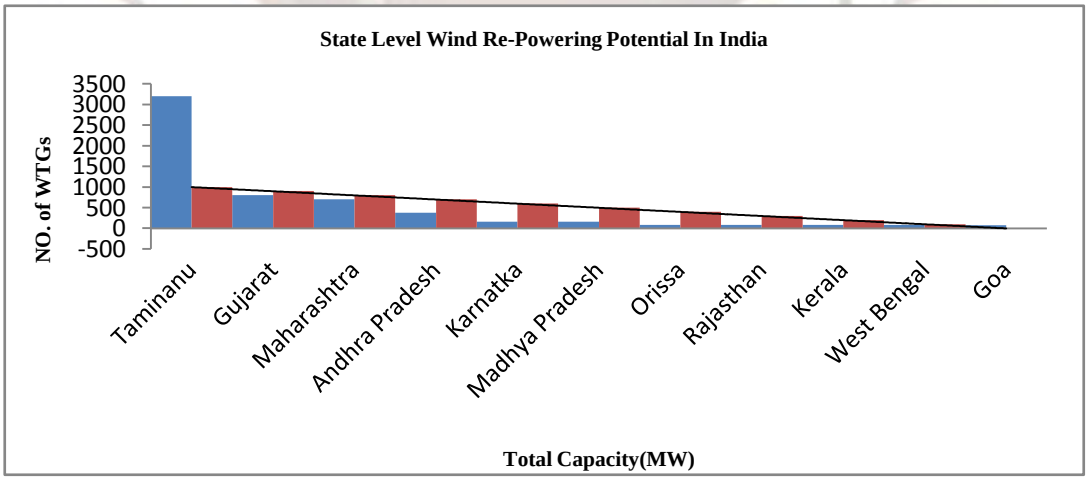

Fig -4

6. CASE STUDY

6.1. Germany [8]

Germany is world leader in wind installed capacity.Germany's wind power boom started letter than Denmark's.By end of 2007,Germany had installed 22,247 MW cumulative.Germany is largest wind energy user.It is expected that Germany will also have a major market for repowering.The German Wind Energy Association(BWE) calculated that up to 2020,with a realistic approach,that on-shore repowering potential in germany will be about 15.000 MW.

Statistics from the BWE institute Wilhelmshaven show that re-poweering an old site with 59.3 MW resulted in 168.5 MW in mid 2005,with less than 1%of the 17132 MW of then total installed capacity in Germany.The repoering ratio between new and dismantled capacity was thus 2.84.The rate of power production has more than triple resulting in increased of Green House Gas(GHG) emission. Eligibility criteria for the repowering incentive included that old turbines to be at least 10 years old and the new turbine needs to have at least twice, but no more than 5 times the capacity of the old turbine. The repowering bonus provided the incentive necessary for investment and replacing first generation turbines with modern and efficient converters.

Table 6
Repowering experience in Germany

Repowering experience in Germany		Unit
Number of dismantled turbines for repowering	143	
Reduced capacity	59.3	MW
Number of new turbines installed after repowering	108	MW
New capacity	168.5	kW
Average capacity of dismantled turbines	415	kW
Average capacity of restored turbines	1560	
Reduction factor of number of turbines	.76	kW/kW
Repowering factor	2.84	

In 2007, 108 old turbines were replaced by 45 new turbines. Despite this reduction, the overall output rose by a factor of 2.5 from 41 MW to 103 MW. Halving the number of turbines, but doubling their power and tripling the total energy yield has now become the new formula for success in the German on-shore wind energy sector (Table 6).

Despite this incentive, repowering has just begun and, given the regulations on siting, the wind industry argues that the feed-in-tariff repowering incentive is insufficient. Some other stumbling blocks for implementing repowering solutions include local government restriction on hub height or total turbine height, and setback requirements between installations and residential areas. Despite these barriers, the wind repowering opportunities in Germany are enormous.

6.2 Netherland[5]

The Dutch government has st target for the installed capacity of wind energy in country. For the year the 2020 the total target in installed generation capacity of 2750 MW,of which 1250 MW offshore and 1500 MW on land. By replacing of old and small turbines by nwer,larger turbines,a larger contribution to the national target can be achived.And ofcource the production of electricity will increase.

In this strategy wind turbines with an age of 10 year and more.will be replaced by newer and larger turbines.Turbine an installed capacity of 250 kW and less will be replaced by a turbine of 750 kW(Table 7) and a diameter of 50 meters.Turbine between 250 kW and 750 kW,will be replaced a new turbine of 1 MW (65 meters).

Table 7

Summarised the Effect of Repowering

Number of turbines	249
Number of replaced turbine	249
Current installed capacity	359 MW
	513 MW
Capacity after 10 year	200
New installed capacity	46 MW

Replaced capacity Installed capacity gain	154 MW

6.3 Tamilnadu[6]

Re-powering of old wind farm is a huge opportunity in India.There number of such old wind farms in southern districts of Tamilnadu.There are numerous turbines in-Table 8

Repowering ratio	
Old wind power project capacity	7.35 MW
New wind power project capacity	16 MW
Repowering ratio	12.18

As per above analysis we find that the Plant Load Factor (PLF) increase to 27%[6].Improved overall performance and hence increased power generation from 12.5 million to 30.0 million.

7. CONCLUSION

The repowering potential and its benefits offer an attractive opportunity to improve the quality of power generation and efficiency of the wind sites.the the right policy framework and incentives could significantly change the landscape of aging of wind farm in India.

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stalled in state of Tamil Nadu that there are older than 15 year and some between 10 to 15 years ago.These all turbines are sub megawatt with low hub height.

Gamesa announced first phase of repowering project in Coimbatore –India.The wind farm had 29 unit of 300 kW turbines and 2 unit 500 kW BHEL Nordex turbines for total capacity 9.7 MW.The cuf of old wind farm cas about 13 to 17% and the turbines were of 1995-1996 vintage.In their Gamesa intended to replace the old turbine.

In first phase the project Gamesa has successfully replace is about 8300 kW turbine s and 2500 kW turbines with 4 G-58-850 kW tubines.The repowering potential in our estimates is about 1.5-2GW.in India.

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