Simulation and Comparison Analysis of Single Rotor Centralized Horizontal Axis Windmill with Integrated Micro Windmill with Horizontal Axis in Vertical Plane

Shani kumar[1], Amit Kumar Mandal[2], Hari Kumar Singh[1]

[1]*Suresh Gyan Vihar University, Jaipur, Rajasthan, India*
[2]*Poornima University, Jaipur, Rajasthan, India*

***Abstract*— This paper is regarding to compare the use of wind energy by the help of integrated micro windmills with big centralized windmill . The paper describes the comparison analysis of centralized windmill over integrated micro windmill. Integrated micro windmill can prove a great potential in concern of simplified design, efficient power production as no gear box is used , simplicity and ease in erection , low maintenance , ease in fabrication ,easy transportation to the site and much more benefits can be there . A model of integrated 16 micro windmill, horizontal axis in vertical plane is fabricated for simulation analysis whose picture and various magnitudes , attributes are included in this paper for better understanding .**

Keywords*— Single rotor centralized wind mill, Integrated Micro windmill ,Efficiency , simplified design and ease . fabrication simplification.

I. INTRODUCTION

Renewable energy sources are one of an emerging source for energy harness in present world. We know that conventional energy sources are depleting. The commonly used windmill in current time worldwide is horizontal axis windmill having the capacity around 1-2 MW per machine .A big capacity wind mill, for example in case we talk about windmill manufacturer Suzlon makes model Suzlon S9X suite of 2.1 MW is having diameter 95 m with cut of wind speed 25m/sec , the height of tubular tower 80-100m . For erection of such a big unit it needs more efforts in terms of cost time man power and maintenance. Secondly, the power obtained over wind turbine is a part of the kinetic energy available over the swept area of wind machine is given by $\frac{1}{2} \rho A v^3$ where ρ is the density of wind falling over the blades, A is the swept area and v is the velocity of wind. But in actual practice, the amount of wind falling on the rotor is only over the projected area of the blades of turbine in axial direction . The amount of wind other than over the projected area of the blades of turbine in axial direction simply passes away without any interaction with the machine . Thus valuable energy waste is there due to skipping wind through the vacant area of between turbine blades for a commonly used three bladed turbine . The big unit windmill consists of nacelle behind its hub which is passing the shaft power of rotor to the gear box and to generator in turn. The gear box is having its efficiency so to the generator set we cannot provide 100% power available over the shaft . The introduction of gear box adds up an extra costing to the windmill. The maintenance of a big unit also needs attention ,man power and safety norms . The minimum wind speed requirement and the cut off wind speed are also loss making factors for a windmill .At higher wind speed, the energy is still available with air but for safety norms we cannot utilize that. Similarly below minimum wind speed the windmill becomes unable to produce power .The big units can only be manufactured by large scale industries small scale industries and companies

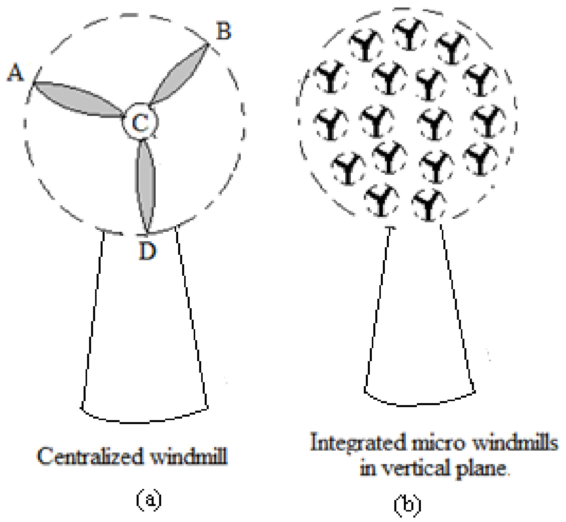

Fig 1

are almost unable to develop high power centralized wind mill. All in all erection and commissioning, maintenance, all protocols of a big centralized windmill is a tedious job in terms of money ,man power ,safety.The solution for problems associated with centralized windmill as mentioned in previous paragraph is to use smaller micro-windmill integrated over same area of exposure as the centralized windmill is having .For example , suppose the diameter of a windmill rotor with blades is 90m . It means the area it will capture for rotation is $\pi D^2/4 = 6358.5m^2$ In Fig 1(a) we can see the centralized large capacity windmill with a single rotor . The amount of energy input to the windmill is taken as amount energy with the wind falling over the entire area of swept of rotor . But In case we consider a little then we can see that the area between points ABC , ACD and BCD in fig(a) is vacant i.e. the wind energy input cannot be taken as the entire swept area of the rotor of windmill while the practical input is only the due to wind fall over projection of blades in axial plane . Thus in place of a big windmill

of single rotor we can use micro windmills in integrated fashion as shown in fig 1 (b) . Thus greater amount of area can be harnessed by this way hence the power output can
be increased by such manner. Similarly fabrication of micro windmills is less tedious as compared to that of

Wind speed (m/s)	Voltage(volts)	Power produced (watt)
1	0.9	0.00167
1.5	1.15	0.00563
2	2.1	0.01336
2.5	2.6	0.026093
3	2.9	0.045
3.5	3.6	0.0716
4	4	0.106
4.5	6.2	0.1521
5	6.8	0.2087
6	7.3	0.3607
8	8.1	0.85504
10	8.8	1.67
12	9.2	2.8857
14	9.9	4.5742
16	10.5	6.828
18	11.1	9.7219
20	12.36	13.338
22	14.78	17.75
24	16.35	23.04
26	18.46	29.30
28	18.46	29.30
30	18.46	29.30

Table 1

larger one. The transportation of micro windmill for integration over the site is also easy and can be done in step or in phases .

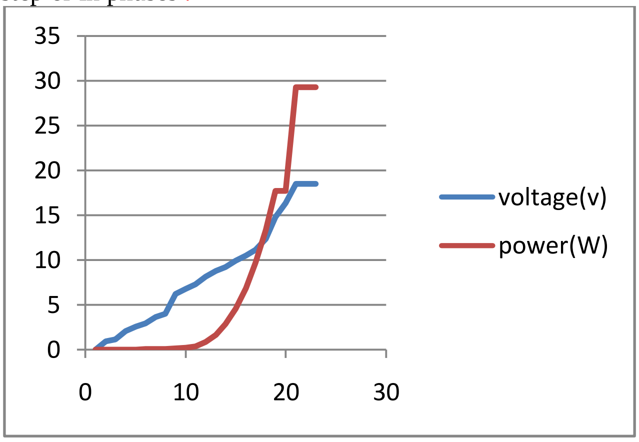

Fig 2

II METHODOLOGY

A simulation over a integrated micro windmill system is done as shown in fig(3)

Fig-(3)

to find out the possible advantages and disadvantages of the two methods i.e. big centralized windmill and small integrated micro windmill. For simulation a model of 16 windmills with diameter of rotor 10cm each are implanted over a vertical frame as shown in fig 3 . The electrical connection of the windmill are made in series to get elevated voltages while operation. The power produced with varying wind speed is given in table 1 (with a single micro windmill) . The simulated data is collected and shown in table 1.The advantages of using integrated micro wind mill is , we are not bound to keep the shape of area of projection of air to fall upon to be circular , since it is composed over several micro windmills hence any suitable shape can be adopted as area of projection . Since all micro windmills are connected directly to the generator hence no efficiency loss is there related to gear box. It reduces the cost ,ease in fabrication and light in overall weight of machine . In case of centralized windmill , in case the windmill fails by some fault the entire unit is tripped making a loss of significant amount of power up to the time the maintenance of windmill is accomplished . In case of using integrated micro windmill having problem with one unit or few than that particular micro wind machine can be 'by passed' so that power production is still there with rest of the micro windmills . The problem of bird hit and death with centralized wind mill is more , with integrated micro wind machines since the visibility is better with the birds hence lesser probability of bird hit and death is there .

III RESULTS

With doing experiments with integrated micro windmills and with its simulation and comparison it is found that it is may be advantageous to use wind power with integrated micro wind mills of same capacity rather than using a big centralized windmill . The power production with increasing wind speed with a single micro windmill increase up to wind speed of 16m/s . With increasing beyond this speed of wind , the power production remain constant as shown in table 1 .

IV. CONCLUSION

The papers motive is to attract the interest of concerned and interested peoples , organizations and department for moving with development of integrated micro windmill in vertical axis rather than big capacity centralized wind mill . Same power can be generated with better flexibility regarding the operation , maintenance , cost compared to various other tedious attributes with big centralized windmill . There is tremendous research opportunities in this field . This may prove a better way to harness wind energy .The efficiency of micro windmill has to be increased to higher level to get overall output with greater work output for same wind speed .

REFERENCES

[1] M.N Nahas, A.S Mohammad, M.Akyurt and A.K.E I-kalay (1987) Energy Source 9,elsvier publication.

[2] Mohamed Elkhayat, (2007), Basic and types of wind turbine,EL Ahram Printers, elsvier publication.

[3] Adan Ritchie, Randall Thomas,(2005) Sustainable urban design,second Edition, elsvier publication.

[4] Ove Arup and partners, (2004), planning for renewable energy,queen's Stationary office, elsvier publication.

[5] Edward s.cassedy (1998) prospect for sustainable energy, combridge University press, second edition, elsvier publication.

[6] Peter F. Smith (2003) Sustainability at the cutting edge, Architecture press Elsvier publication.

[7] Mohsen Mostafavi (2010), ecological urbanism, lars muller publication. Harvad university, elsvier publication.

[8] Silmalis Linda (2010) April 20, p 9. Wind mills for year roof. Australia The Sunday Telegraph; elsvier publication.

[9] A fletlner, (1926) Londan, The story of the rotor, Crosby luck wood and son, Elsvier publication.

[10] P.D.fleming and S.D Probert (1982) applied energy,12(1982),pp.327-31,of Proposed, three-sail savories- type wind-rotor elsvier publication.

[11] S.P. Govinda raju, and R. Narasimha,(1979), c2 (pt.1).pp.67-82, A low-cost Water-pumping wind mills using a sail-type savonius rotor, proc. India Academy of Science. Elsvier publication.

[12] P. N Shankar (1976) The effects of geometry and Reynolds number on Savonius type rotor, memorandum AE-TM-3-76, National Aeronautic Laborabe Bangalore,india , elsvier publication.

[13] B.Hurley (1978) A vertical-axis sail wind mills, low energy system ltd, Elsvier publication.

[14] B.G Newman and T.M. Ngabo (1978), The design and testing of a vertical Axis wind-turbine using sails, energy, conservation 18(3),pp 141-54, Elsvier publication.

[15] J.Neeahan, (1965) science and civilization of china, vol 4,pt-11, Cambridge university press, London, elsvier publication.