International Journal of Current Trends in Engineering & Research (IJCTER)
e-ISSN 2455–1392 Volume 2 Issue 3, March 2016 pp. 190 - 196
Scientific Journal Impact Factor : 3.468
http://www.ijcter.com

LADDER MILL – CASCADED AIR ROTOR SYSTEM

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Abstract—The Ladder Mill is the upcoming generation of wind mills with economic and technical advantages over present systems. Ladder Mill consists of number of air tethered wind turbine that rotates about a horizontal axis in retort to wind, generating electrical energy. This electrical energy is transferred down for utilization, or to battery banks or the power grid. Helium filled balloon with the Rotating System, which floats at an altitude as selected by the operator for the suitable wind flow. An aerodynamic phenomenon normally helps the helium balloon to lift up while rotation and also helps to stabilized the system. To keeps the mechanism at controlled and restricted location.

Now these days it is very needful to opt the renewable source of energy in the whole world. For the same necessities we require advance options for upcoming era, hence Ladder Mills are going to be very helpful for the Future.

Keywords—Green Energy, MARS, Wind turbine, Eco Friendly

I. INTRODUCTION

In the present era of technology, green sources are the most essential parts that can be used for gaining energy in economic and best way.

Various renewable sources like wind, solar, and tidal energy can establish bonus for human being and others too. Use of wind for generation of energy by using suitable eco-friendly technique is discussed in this paper.

II. LADDER MILL

A **Ladder mill** is a hypothetical airborne wind turbine consisting of a long string or loop of rotating balloons (across horizontal axis). The loop or string of rotating balloons (the "ladder") would be launched in the air by the lifting force of helium gas, until it is fully unrolled, and the top reaches a height determined by designers and operators; some designers have considered heights of about 30,000 feet (9144 meters), but the concept is not height-dependent. The ladder mill method may use one endless loop, two endless loops, or more such loops.

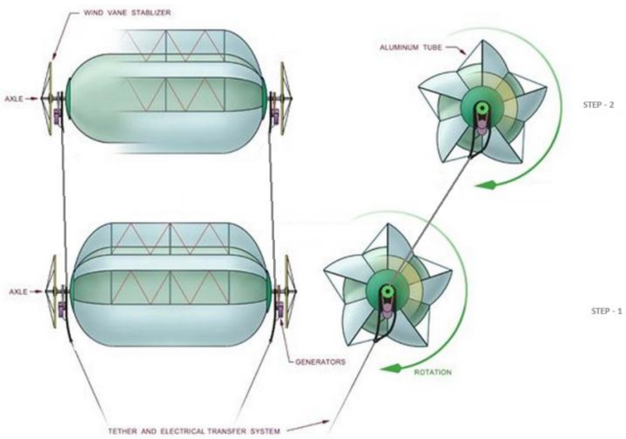

Figure 1: Construction of The Ladder Mill

Construction of the Ladder Mill is as shown in the Figure 1. It has following important parts;

Figure 2: Rotating Cylindrical Balloon

Cylindrical Balloon: It is the cylindrical shape balloon (Figure 2) filled with helium which is lighter than air, hence it could be placed above 300m height, whereas conventional windmills could be limited upto 125m height.

Aluminum Tube: This is used to restrict air flow and gives thrust for the rotor to rotate in the direction as shown in the figure. Here it converts the actual linear motion of wind flow energy into rotary motion, which is necessary to rotate the generator shaft.

Wind Vane Stabilizer: It is one of the important parts of Rotating balloons. It restricts the system in horizontal direction, and gives stability to the balloon.

Axle: It acts as a frame of rotating balloon which is a single shaft connecting balloon, and aluminum tube to the generator shaft, hence it is the power transferring element of the rotating system.

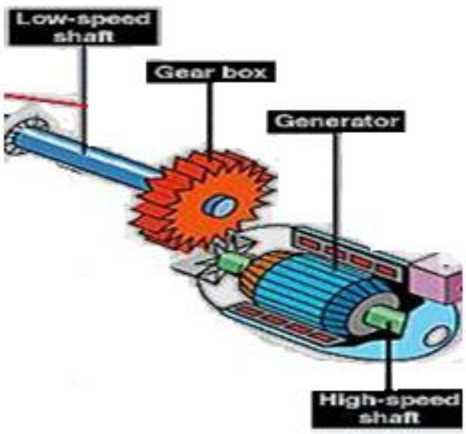

Figure 3: Shafts, Gear Box and Generator

Generator: It the actual machine which converts the rotary motion into electrical power (Figure 3). There are two conventional generator used for power generation and transfers power to the base station.

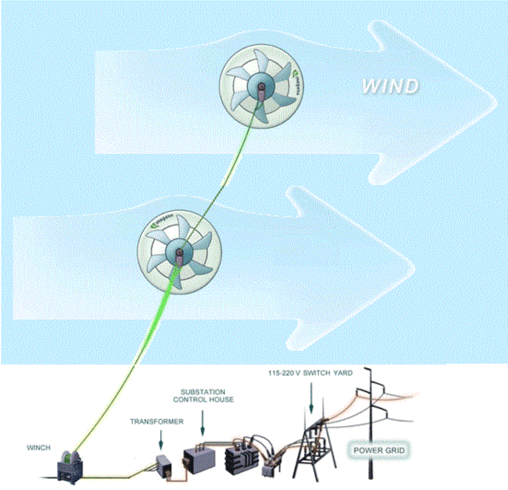

Figure 4: Ladder Mill Connected To Grid

Estimated performance data is shown in the graph below. The Annual Energy Output range accounts for various non-standard wind distributions.

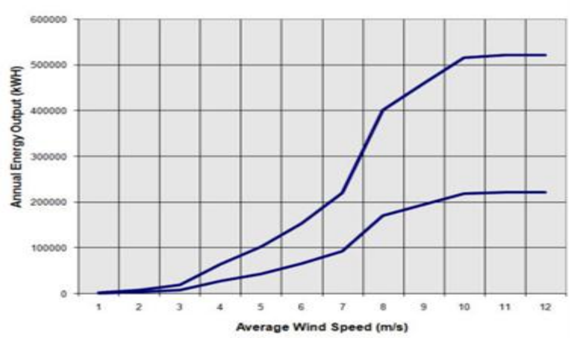

Figure 5: Performance of 100kW Unit

Specifications For 100kW Single Unit Performance	
Product	Model 100kW
Rated Power	101,000 Watts
Size (Diameter x Length)	45 ft x 100 ft (plus blade height of 22 ft each)
Weight	Under 13,000 lbs
Volume of Helium	200,000 cubic feet
Tether Height	750 ft standard - up to 1,500 ft optional tether length
Start-up Wind Speed	2.5 m/sec - 5.6 mph
Cut-in Wind Speed	3.0 m/sec - 6.7 mph
Rated Wind Speed	12.0 m/sec - 26.8 mph
Cut-out Wind Speed	24.0 m/sec - 53.7 mph
Maximum Wind Speed	30.0 m/sec - 67.1 mph
Temperature Range	-40¼C /-40¼F to +45¼C/+113¼F
Generators	100 kW Total
Output Form	380 V 3 Phase 50 Hz, 480 & 600 V 3 Phase 60 Hz or Regulated DC
Warranty	One Year
Life Cycle	10 to 15 Years
Price (Rs) (Estimated)	₹ 33000000

Figure 6: Details and Specifications of 100kW Air Rotor Unit

III. TARGET OF LADDER MILL

- Off grids for remote users such as isolated areas, cell towers and exploration equipment.
- Developing nation infrastructure which is partial or fictional.
- Rapid deployment to disaster areas for power to emergency and medical equipment, water pumps, and relief efforts like Katrina, Tsunami and military applications.

IV. ADVANTAGES OF HIGH ALTITUDE WIND POWER AND LADDER MILL

Winds at higher altitudes become steadier, more persistent, and of higher velocity. Because power available in wind increases as the cube of velocity (the velocity-cubed law),[1] assuming other parameters remaining the same, doubling a wind's velocity gives 2^3=8 times the power; tripling the velocity gives 3^3=27 times the available power. With steadier and more predictable winds, high-altitude wind has an advantage over wind near the ground. Being able to locate HAWP to effective altitudes and using the vertical dimension of airspace for wind farming brings further advantage using high-altitude winds for generating energy. In each range of altitudes there are altitude-specific concerns being addressed by researchers and developers. As altitude increases, tethers increase in length, the temperature of the air changes, and vulnerability to atmospheric lightning changes. With increasing altitude, exposure to liabilities increase, costs increase, turbulence exposure changes, likelihood of having the system fly in more than one directional start of winds increases, and the costs of operation changes.

In each hemisphere’s winter, wind power density patterns are generally similar to the annual patterns, but the bands of high winds at the mid-latitudes near 10,000 m are generally broader, extend further equator ward, and have higher wind speeds .

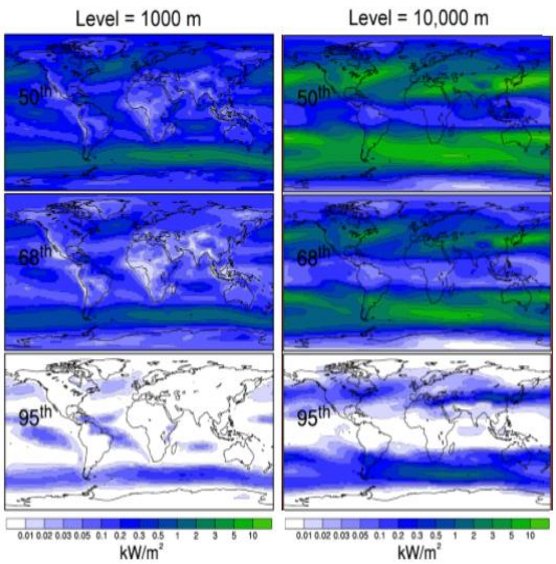

Figure 7: Wind power density (kW/m2) that was exceeded 50%, 68%, and 95% of the time during 1979-2006 at 1,000 m (left) and 10,000 m (right) from the NCEP/DOE re analyses[2][5].

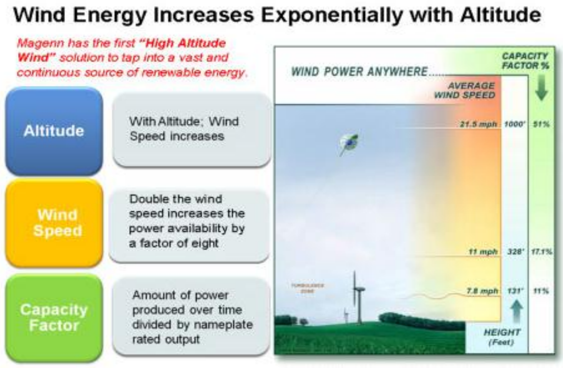

Figure 8: High Altitude Winds

Similarly Ladder Mill is very much advantageous as mentioned below,

- Ladder Mill Rotor System is less expensive per unit of actual electrical energy output than competing wind power systems.
- Ladder Mill Rotor System will deliver time-averaged output much closer to its rated capacity than the capacity factor typical with conventional designs.
- Efficiency of single unit will be 40 to 50 percent. This is hugely important, since doubling capacity factor cuts the cost of each delivered watt by half.

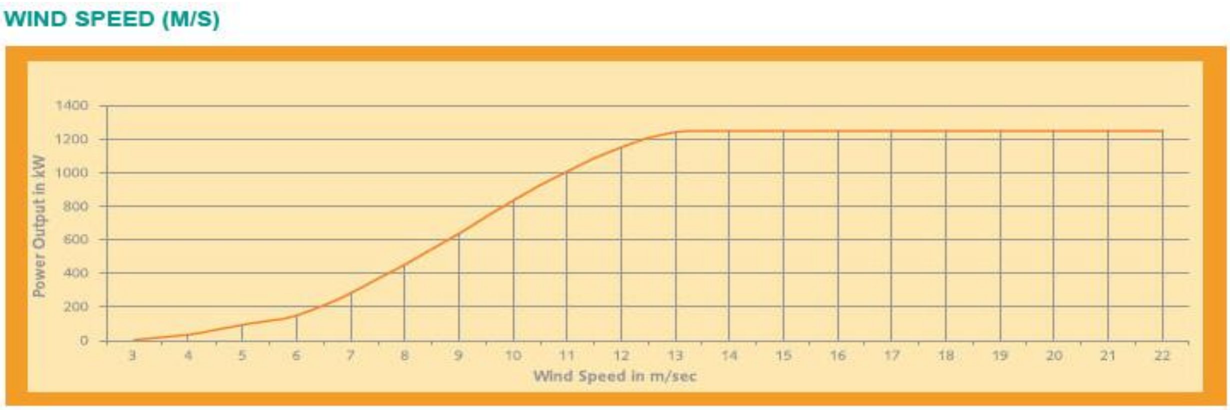

Figure 9: Power Output With Respect To Wind Speed.

District	Available land area suitable for Wind Power (Ha)	Estimated Potential (MW) (Based on % land availability)			
		25%	50%	75%	100%
Amreli	59180	1321	2642	3963	5284
Bhavnagar	19097	426	853	1279	1705
Dahod	11119	248	496	745	993
Jamnagar	125338	2798	5595	8393	11191
Junagad	17412	389	777	1166	1555
Kutch	49210	1098	2197	3295	4394
Porbander	8531	190	381	571	762
Rajkot	114776	2562	5124	7686	10248
Surendranagar	50793	1134	2268	3401	4535
Total	**455457**	**10166**	**20333**	**30499**	**40666**

Figure 10: Suitable Area For Wind Power in India

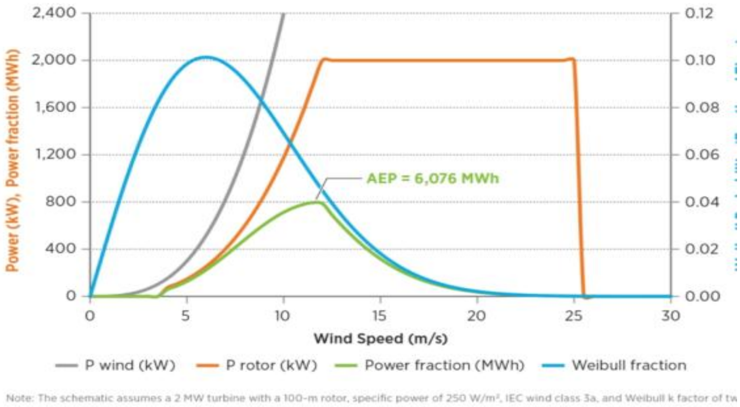

Figure 10: Variation of Various Parameters with wind speed

- Conventional wind generators are only operable in wind speeds between 3 meters/sec and 28 meters/sec. Ladder Mill Rotors are operable between 1 meter/sec and in excess of 28 meters/sec.
- Ladder Mill Rotors can be raised to higher altitudes, thus capitalizing on higher winds aloft. Altitudes from 400-ft to 1,000-ft above ground level are possible.
- Ladder Mill Rotors are mobile and can be easily moved to different locations and altitudes to correspond to changing wind patterns.
- Wind farms can be placed closer to demand centers, reducing transmission line costs and transmission line loses.

Figure 12: Cascaded Air Rotor System

V. CONCLUSION

This type of technology can trim down our dependencies on fossil fuels which are getting down day by day. As there is no pollution in this system. Green Energy get produced which can reduce green house gases. By implementing this near to Demand centers expenditure on power lines can be controlled.

Due to the effects of global climate change on the wind resource in the air are unknown at the moment, future work should include wind speed attribution and trend analyses. If this technology is implemented it can eliminate worldwide power problems.

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