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ESTIMATION OF WIND POWER POTENTIAL FOR PASNI, COAST OF BALUCHISTAN, PAKISTAN.

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Abstract: The study of the prospect of Wind power potential for Pasni has been made from the available meteorological data. For Pasni the peak months are April, May and June. The monthly average wind speed ranges from 4.5 m sec^{-1} to 8.0 m sec^{-1} and the maximum extractable wind power was found to be 221 Wm^{-2} using 1 m diameter. turbine blade. The power out put for slow and fast wind machine have been estimated to see the possibility of its use for water lifting and small scale power generation. Along with this the feasibility of performance of a 20 KW aero- generator was also examined for Pasni.

Keywords: Coast of Baluchistan, Pasni, potential, wind energy,

INTRODUCTION

Pasni is a coastal city of Baluchistan located at 25°16′ Latitude and 63° 31′ Longitude. This is a small remote city of Province of Baluchistan with moderate population growth resulting in increased energy requirement.

Due to high cost of fossil fuel, there is a need to harness other source of energy for local population. Pasni is a coastal city, with high wind speed available almost all the year round.

In this paper a preliminary investigation of the potential of wind power generation employing six years (1995 to 2000) of wind speed data obtained from Pakistan Meteorological Department Karachi office is made. The maximum available and extractable wind power is calculated. The power output for slow and fast wind machine with different blade diameters has been calculated. The performance of a 4 KW aero generator for Pasni has also been examined.

WIND DATA

The data for this study was obtained from Pakistan Meteorological Department Karachi office. The data consisted of six years duration (1995 to 2000). It is monthly average wind speed calculated at a height of 10 m.

METHODOLOGY

Generation of power from a windmill requires continuous flow of wind at a rated speed. This is difficult to accomplish because wind by its very nature is not constant and does not prevail at a steady rate. It fluctuates during short period of time. The speed of wind is also dependent on height above the ground. In order to estimate the wind speed at any height, Hellmann “s exponent law can be used [Musgrove 1987]

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$$V_{(h)} / V_{(10)} = (h/10)^{\alpha} \quad (1)$$

Where $V_{(h)}$ is the wind speed at height h and $V_{(10)}$ is the wind speed at 10m height and α is the Hellmann's exponent. For flat and open area α is approximately equal to one seventh. The available power in wind at any wind speed may be estimated as [Alnaser 1993a,b]:

$$P = (1/2)\, \rho\, V^3 \quad (2)$$

Where ρ is the air density, which was assumed to be 1.225Kgm^{-3} and V^3 is monthly mean wind speed in m sec^{-1}. This available power can not be totally extracted by any wind machine. The maximum extractable power from any wind machine is limited by famous Betz relation [Betz 1942] which assigns power co-efficient C =16/27 for the maximum performance of a wind machine.

$$\text{Maximum extractable power per meter} = (1/2)\, \rho\, Cp\, V^3 \ \text{w m}^{-2} \quad (3)$$

SLOW WIND MACHINE (SWM)

An 18 bladed horizontal axis slow wind turbine having 5 to 10 m diametermeter blade was selected for the study. The maximum power likely to produce by this type of machine can be calculated by using the following expression [Desire and Gourieres 1982].

$$P = (0.15) * D^2 * V^3 \quad (4)$$

The power is in watt and diametermeter in meter and wind speed is in m sec^{-1}. The power output of this SWM is given in Table 1.

Table 1: Power output using slow wind machine.

Diameter of the wind wheel in m	Power in KW V = 4.5 m sec^{-1}	Power in KW V = 8.5 m sec^{-1}
5	0.34	2.3
6	0.50	3.3
7	0.70	4.5
8	0.90	5.9
9	1.10	7.5
10	1.30	9.2

FAST WIND MACHINE (FWM)

A three bladed horizontal axis fast wind machine having 5 to 10 meter diametermeter blade has been chosen. The maximum power likely to be produced by this machine can be calculated by using the following equation [Desire and Gourieres 1982]

$$P= (0.20) * D^2 * V^3 \quad (5)$$

Where P is expressed in watt and D in meter, V in m sec$^{-1.}$ The power output of FWM is shown in Table 2.

Fig. 1 gives the power curve for 20 KW aero- generator for which the rated speed V_r is 8.5 m sec^{-1} [Alnaser 1993]. The cut-in speed is dependent on the rated speed of the machine. The cut-in speed can be calculated by the following equation [Pande and Chandra 1986]:

$$V_{ci} = (0.15)^{1/3}\ V_r \quad (6)$$

Where V_r is the rated speed of the machine and V_{ci} being the cut-in speed. Using above expression the cut-in speed may be calculated.

Table 2: Power output using fast wind machine.

Diameter of the wind wheel in m	Power in KW V = 4.5 m sec^{-1}	Power in KW V = 8.5 m sec^{-1}
5	0.46	3.0
6	0.66	4.4
7	0.89	6.0
8	1.2	7.9
9	1.5	9.9
10	1.8	12.3

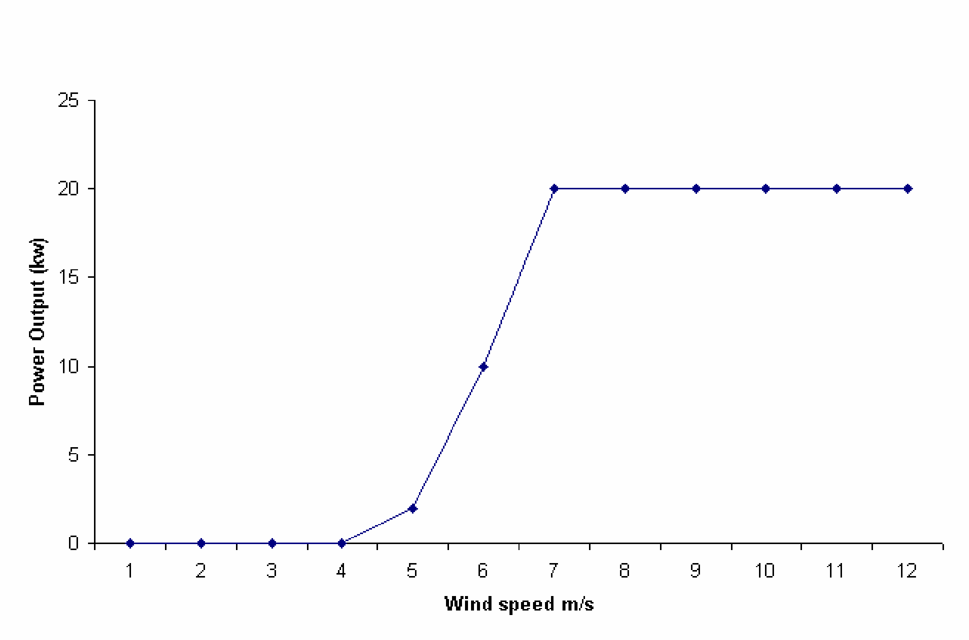

Fig. 1: Power curve for $\bar{2}0$ KW selected machine.

RESULTS AND DISCUSSION

Fig. 2 shows the average monthly wind speed for the year (1995-2000) for Pasni. The availability of the monthly mean wind speed was established using the annual mean standard deviation of the data. The monthly mean standard deviation for Pasni was found to be 1.14 m sec^{-1} and standard error co-efficient was found to be 0.05 m sec^{-1}. From Fig. 2 it also appears that the peak potential months are from April to June as these months shows the maximum wind speed of 8.5 m sec^{-1} whereas the annual average is 6.3 m sec^{-1} while the lowest wind speed was 3.9 m sec^{-1} observed in the month of December.

Shown in Fig. 3 is the yearly variation of wind speed for Pasni during the year 1995-2000. In these years the wind speed remained almost constant. Shown in Fig. 4 is the plot of available and extractable wind power using 1m diameter blade.

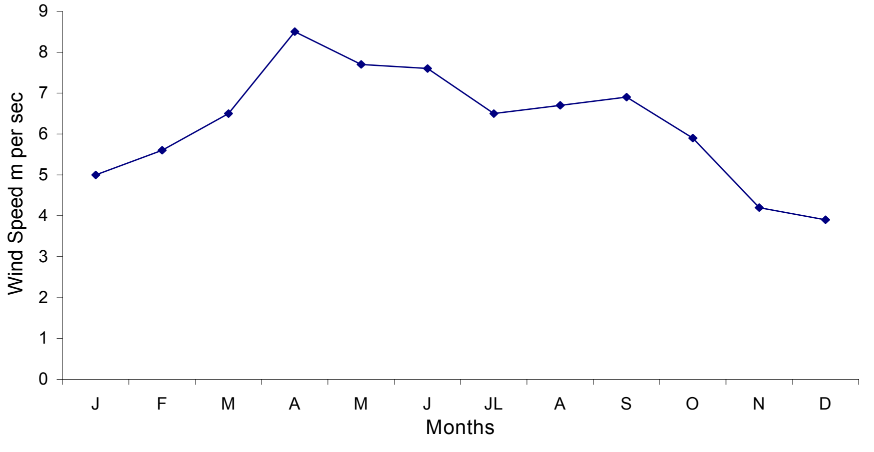

Fig. 2: Annual variation of Wind speed for Pasni.

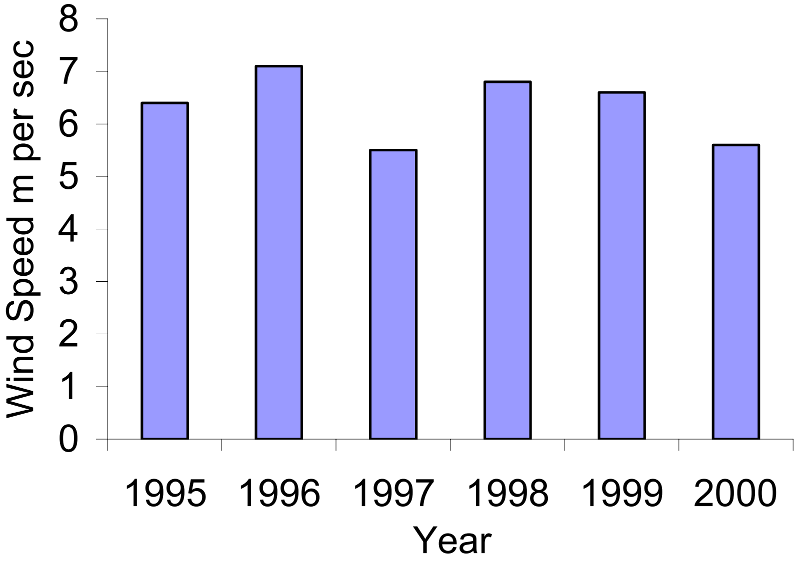

Fig. 3: Yearly wind speed availability for Pasni.

The annual variation of extractable wind power for slow and fast wind machine using different diameter blade for 4.5 m sec^{-1} and 8.5 m sec^{-1} wind speed is shown in Fig. 5. Tables 1 and 2 give the extractable wind power for slow and fast wind machine.

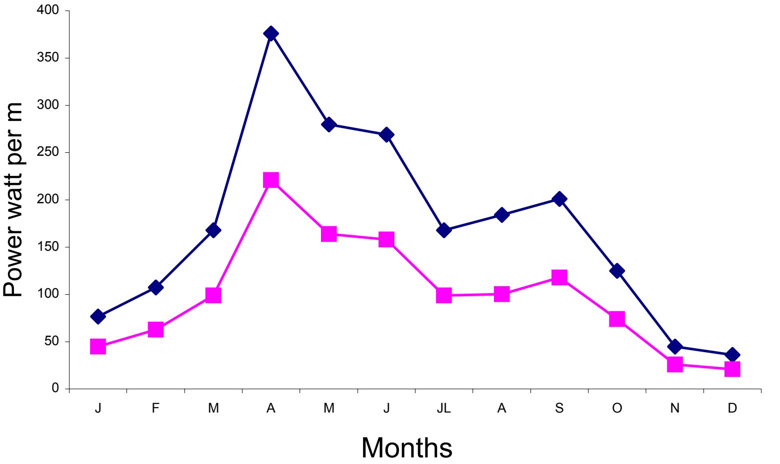

Fig. 4: Annual variation of available and extractable power for Pasni (Blade diameter 1m).

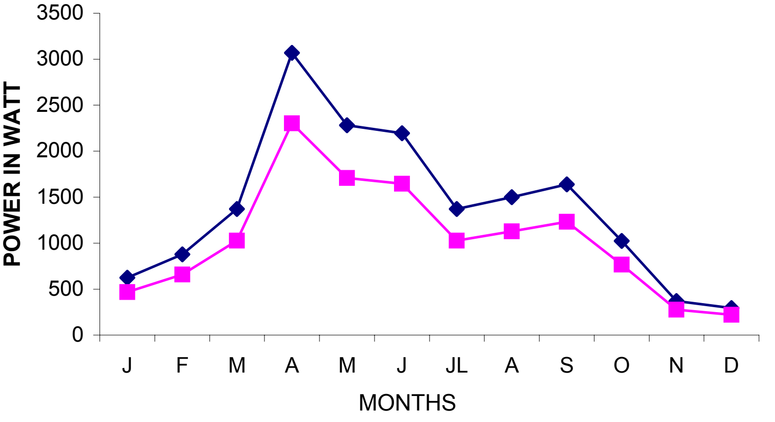

Fig. 5: The variation of extractable wind power using fast and slow wind turbine for Pasni (blade diameter 5 m).

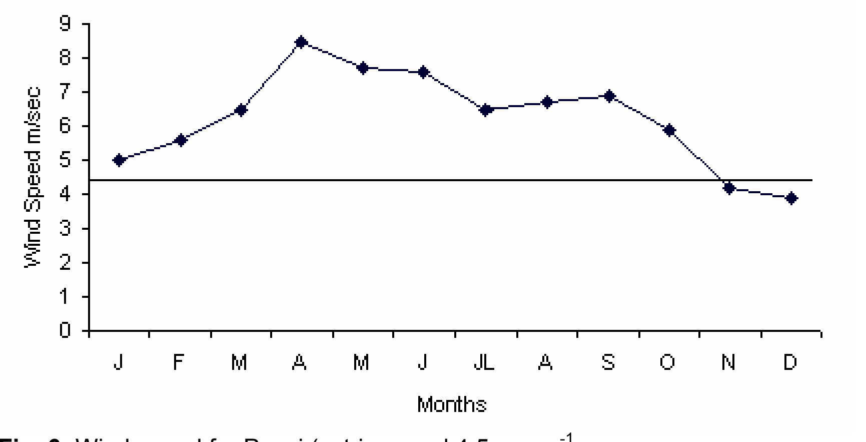

Fig. 6: Wind speed for Pasni (cut-in speed 4.5 m sec^{-1}.

As given in Fig. 1 the rated wind speed of a selected 4KW wind machine is 8.5 m sec^{-1}. Using Eq. (6) the cut-in speed was found to be 4.5 m sec^{-1} since the power from a wind turbine is defined as the fraction of the total time at which the wind speed is sufficient to operate the machine. The generator will not generate power below the cut-in speed V_{ci} and wind turbine out put will be constant at a rated speed (Fig. 6). The situation for Pasni is very encouraging from the power generation point of view, since the wind speed is well above threshold for almost all the year with the exception of November and December.

CONCLUSIONS

Wind power potential has been assessed using wind data for Pasni. It was observed that the annual wind speed exceeds 4.5 m sec^{-1} for over 80% of time of the year. The result for Pasni confirms the availability of high wind energy potential for south and coastal areas of Sindh and Baluchistan. The 4 KW generators can be used for producing electricity throughout the year. For water lifting from the deep well slow wind machine can also be used almost all the year except for the month of December for which the diesel back up generator can be used. At present a 17.48 MW power plant is already working and supplying power to Pasni town and nearby coastal areas of Baluchistan since 1999.

With the availability of strong wind throughout the year, the wind power potential can be exploited with efficient and slow/fast wind machine to meet the ever increasing energy demand of this coastal area.

Acknowledgement

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