Wind power development in Sindh

By M.H. Panhwar

We have to speak with caution about application of windmills in Pakistan and their economy. In their home country i.e., Netherlands, they disappeared very fast between 1920 and 1950.

Hardly 7-8 per cent of those existing in 1920 have survived. These have been protected by efforts of the Society for Preservation of Windmills, (SPW) which in turn is being helped by the government and the National Tourist Bureau.

The windmills had ceased to be economical as compared to diesel or electric power. Most of the windmills in the Netherlands, Denmark and other European countries were huge monsters having diameter of 30 meters and stood on massive towers of heights of more than 20 meters. With the highest wind velocity, at best they could develop only 20 horse-power or 15 KW.

Though the maintenance cost is negligible, still it cannot be considered as economical as diesel engines, which will at the most cost only 5-7 per cent of the cost of windmills for the same power.

For some time in early 20th century, it was thought that windmills will possibly become extinct, but the new developments for use of windmills in desert zones of Australia for pumping water and storing it for use of sheep and high wind velocities in certain northern Europeans countries lying between 40-60 degree latitude again revived interest in them.

In the 50's, wind power research organizations were established in most of the advanced countries. Denmark was then leading. Now windmills are used for power development but velocities have to be very high to make them economical. Such velocities exist in northern Europe and also during monsoons from Bangladesh to Andra Pradesh, but not in most tropics and sub-tropics.

High wind belt: Winds in Sindh are caused by heating of air in Rajasthan and Thar deserts and rising of this hot air up and its replacement by cooler air blown from surface of the Arabian Sea, moving in west-south-west to east-north-east direction to the desert.

A high wind velocity belt exists between Karachi and Keti Bunder and runs from Keti Bunder to Mithi and from Karachi to Hyderabad and beyond to the desert. Wind velocity data from some stations in India and Baluchistan shows that the wind velocity reduces south and north of these belts. It also reduces as one moves inland wards i.e., eastwards. Chore has less wind velocity than Hyderabad which has less than Karachi.

In the same way Bhuj and Raikot have less wind velocity than Duwarka. The wind

velocity at Duwarka and Veraval in Kathiawar and further to Mumbai reduces as one moves south of Keti Bunder. Wind velocity also reduces if one moves from Karachi along the Baluchistan coast to Soanmiani, Ormara and Pasni.

The present wind velocity data shows that maximum wind velocity occurs, at Manora Karachi. If wind velocity is higher at any place between Karachi and Keti Bunder, the different cannot be more than 5 per cent, which can give advantage of 15.76 per cent higher power from the same windmill. The wind velocity at Duwarka and Veraval are less than at Karachi, because Karachi and Keti Bunder are nearest to centre of Rajasthan and Thar Desert.

Pattern: There are long term data for wind velocity at Manora Karachi. It appears that wind velocity data for the whole Sind coast will be similar or about + 5 per cent. Whether windmills will be feasible in Sindh can be determined from wind velocity patterns of Manora throughout the year. During a year winds of different velocities blow in kilometres per hour (kph) at Manora Karachi for the following hours:

* 12-20 kph at an average of 16 kph for 2,716 hours.

* 21-30 kph at an average of 25 kph for 1,344 hours.

* 31-40 kph or at an average of 35 kph for 282 hours.

Effects: In January 2002, Pakistan Council of Renewable Energy Technologies (PCRET) advertised for supply of 5 KW wind mills at 39 kph wind velocity. This type of wind velocity exists for less than 288 hours annually or an average of 46 minutes a day at Manora.

A 5 KW windmill designed for at 39 k.p.h, will produce 3.3 kilowatts (KW) at 35 kph It will produce 1.35 KW at 25 kph and 0.345 KW at 15 kph.

Velocity: One important factor in windmills in that power generated by the same windmill depends upon the cube of wind velocity, i.e., if wind velocity is increased from 10 to 40 kph, power developed at 40 kms will be 64 times than at 10 kph. If the power developed at 10 kph is 1 KW, the power developed at various wind velocities shall be as under:

* 10 kph ---- 1 KW.

* 15 kph ---- 3.75 KW.

* 20 kph-----8KW.

* 25 kph ---- 15.25 KW.

* 30 kph ---- 27 KW.

* 35 kph ---- 42.875 KW.

* 40 kph ---- 64 KW.

This only shows the importance of wind velocity in wind power development and we are planning windmill farms without proper investigations and planning, for wind velocities and durations which do not exist in actual practice in Karachi or along the coast.

Though wind velocity at Karachi is 31-39 kph, it is only for 282 hours annually or about 45 minutes a day and on no day more than 2 hours. Windmills cannot be designed for this velocity on the whole Sindh coast.

Wind velocity of 21-30 kph (average 25 kms) is available for 1,344 hours annually and between 4-6 hours a day from mid-April to Mid-September and less than 4 hours a day in rest of the months. The annual average utility at this wind velocity will be 15 per cent.

Wind velocity of 12 to 20 k.p.h or an average 16 k.p.h will be available for 2,716 hours and average annual utility percentage will be 31 per cent.

One thus has to determine the range within which governor of windmill is to be adjusted for best performance. It is also known that if governor is adjusted for 16 kph velocity, it will produce less power at 25 kph as windmill will tilt away from wind direction at that velocity, to expose less area directly to wind. The power of wind on a 5.5 meter diameter windmill at 16 kpm windmill shall be 1.336 KW as shown by the following formulae:

Power KW = C x Area x (wind velocity in kph)3.

Where C the constant is, 0.000137 and power available in the air at the 16 kph will be i.336 I(W. However only on 59.3 per cent of this power is theoretically extractable and most of wind mills extract only 30 per cent or only 0.4 KW at this velocity. Slow speed large diameter wind mills extract about 20 per cent. This 30 per cent is not final efficiency as windmill generators also having an efficiency of 85-90 per cent, produce 12, 24, 48 or 120 volt direct current for charging storage batteries, a converter is needed if it is AC generator. The loss at converts and batteries etc may further reduce the over all efficiency, to 25 from 30 per cent produced by windmill. At the best it shall be 30 per cent of 1.334 or O.4 kw.

The above formula also shows that power produced will be cube of wind velocity and square of diameter.

Cost of windmills power: There are different claims for cost estimates of KWH (kilowatt-hour) from windmill power, varying from Rs0.60 to Rs60. The cost will depend on wind velocity and at low wind velocity of 20 kph will be 8 times that at 40 kph. It also depends upon time; windmill will be operative during the year. If windmill operates only 33 per cent of time, copper unit will be 3 times that at wind availability for 24 hours a day and

365 days a year.

The cost per KWH at half the designed wind velocity and annual utility for 1/3rd of time or year, will be 24 times than claimed and planned. These factors need to be studied and if the power generation cost is found economical, windmill farms may be established. It is easy to get funds from aid agencies for any wasteful project but waste of these funds is to be avoided. It is claimed that prices of oil and gas are going to increase and that will make windmills economical. It is not realized that cost of windmills will also increase proportionately in future.

Velocity and height: Wind velocity increases with height and it also increases if velocity on windward side is higher. At low wind velocities, gain on leeward side reduces. Below are some examples:

Thar: In Thar desert area, where conditions are altogether different, where water is available at depth of 50 meters or more, and where people from all over bring cattle for drinking water at appointed places, windmills with galvanized iron storage tanks may be of considerable help. Annual wind velocity data for Chhor in Thar show:

* 21-30 kph for 600 hours;

* 12-20 kph for 1900 hours;

* 8-11 kph for 1400 hours.

It is only logical that windmill can pump water during first two groups of velocities and total 2500 hours, but they will operate for 10 hours a day in May to August and only 2-3 hours during rest of months. In small towns like Chachro, where approximately, 10,000 souls reside, and the water requirement including that of their cattle is approximately 200,000 liters per day. Half a dozen slow speed multi blade mills of 10 meters diameter may solve the town's water supply problems from May to August, but not in other months.

Similarly, if wind mills are installed on dug wells in the desert area, each may pump 50,000 liters of water daily and may solve water problem in an area of 100 square kilometres, depending on its human and cattle population at a given period. The total number of windmills required in the wind belt zone of Thar desert will be 250-300, if installed on wells and at an approximately distance of 10 Ems from each other. Large galvanized storage tanks with overflow to carry water back to the well will be ideal arrangement with trough, for animals, but yet winds, may not be available, when water requirement is maximum.

The above information is based on the author's article and on "Ground Water in Hyderabad and Khairpur Division 1964", and on results of 3-years trial on Southern Cross windmill at Tando Jam and report published in 2nd edition of the same book in 1969. The principles of power production from wind have not changed since then. This

article interested Southern Cross Company of Australia and they supplied 21 foot multi-blade wind mill for trials with 20 and 30 cm diameter reciprocating pumps. This mill was installed at Tando Jam on dug well and water table was kept constant by flowing water back in the well.

Measurements of discharge were taken every five minute. Wind velocity data too were recorded. It could produce 0.4 horse power at about 20 kph. Three years data were summarized in second edition of the same book in 1969. Since then the author is in touch with windmill manufacturers, researchers, and has collected technical publications. The author feels that without collecting wind velocity data, duration of suitable wind velocities and finding most suitable site, the planning windmill farm will meet failures.