Potential of Wind Power in Pakistan

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Abstract

This research report is based on three step strategy, through which wind energy could become an integral part of the national electrical grid of Pakistan. In the first step, an overall view of Wind Energy Generation in the World is carried out, along with a brief description of the components of a typical. Wind Turbine. In the second step, some salient pros and cons of the Wind Energy generation is briefed, in the perspective of Pakistan in particular. In the final step, efforts of Pakistan Meteorological Department and the Government are focused and future prospects and goals are set up to make the usage of this renewable energy both domestically and commercially.

Introduction

Wind power is the conversion of wind energy into a useful form of energy, such as electricity, using wind turbines. Wind energy is a form of solar energy. About 1% to 2% of the energy coming from the sun is converted into wind energy. Generation of air currents is a direct effect of the combination of two phenomena: circulation of hot air and Earth rotation. Wind power comes under the heading of Renewable energy. Other renewable sources of energy include Bio-fuel, Biomass, Geo-thermal, Hydropower, Solar Energy, Tidal power and Wave power. The energy consumed to manufacture and transport the materials used to build a wind power plant is equal to the new energy produced by the plant within a few months of operation. The five countries with the highest installed wind power capacity in Megawatts are (2008):
l.USA 25000 +
2. Germany 24000 +
3. Spain 16500 +
4. China 12000 +
5. India 9600 +' ;
But if we look at how much a country's electrical energy needs are met by Wind Power, it shows a different picture (2008):
1. Denmark 19.1%
2. Portugal 11.3%
3. Spain 11.1%
4. Germany 7.0%
5. Rep of Ireland 7.0%
Measurement of wind is the most important aspect of wind energy. Wind measurements are made by an instrument called anemometer. Wind measurements are made over months and a

sometimes year before a site is chosen for a wind farm. Meteorological department is usually in charge of collecting the data. Typical sensors include, but are not limited to: sonic anemometers, 3-cup and propeller anemometers, wind vanes, temperature sensors (air, water, equipment, and product), solar radiation, electrical current, resistance, power, and voltage.

Because so much power is generated by higher wind speed, much of the energy comes in short bursts. The consequence is that wind energy from a particular turbine or wind farm does not have as consistent an output as fuel-fired power plants; utilities that use wind power rely on other sources of energy generation for times when the wind is weak: thus wind power is primarily a fuel saver rather than a capacity saver.

For a wind farm, an average yearly minimum wind speed of 17-21 km/hr (11-13 mph) is a must. Wind speed between 7.8 - 8.6 meter/second is considered outstanding and above 8.6 m/s is considered superb.

Components and Challenges of Wind Turbine

The main components of wind turbine consist of the Tower, the rotor blades, Nacelle (cover housing) which in turn carries the rotor shafts, gears, electrical generator, heat exchanger and electrical instrument:

i. Tower

The wind is more erratic close to the ground and it blows faster at altitudes. At night, surface winds usually subside while at higher altitudes, they remain more or less the same or even increase. By doubling the height of the tower increases the expected wind speed by 10% and the expected power by 34%. But doubling the height requires doubling the diameter of the tower, which leads to increased costs. Modern towers are made of pre-stressed concrete and or tubular steel segment. Lattice towers of welded steel are cheap but for aesthetic reasons have been replaced by tubular structures. The price of a tower is generally around 20% of the total cost. Tower heights have moved beyond 100m in the large turbines.

ii. Turbine Rotor Blades

Wind turbine blades are most often fabricated by hand using multiple layers of fiberglass cloth. The traditional method is for the sheets to be cut to shape, laid down in a mold by hand, sprayed or rolled with resins, and finally cured.

The maximum blade-length of a turbine is limited by both the strength & stiffness of its material and labor cost. Most modern rotor blades on large wind turbines are made of glass fiber reinforced plastics, (GRP), i.e. glass fiber reinforced polyester or epoxy. Using carbon fiber or Kevlar as reinforcing material is being introduced, which will reduce the; weight of the blade by 30% of more. Steel and aluminum alloys have problems of weight and metal fatigue respectively. They are currently only used for very small wind turbines.

The size of the turbine blade is very important. Tip speed ratio of wind turbines is the ratio between rotational speed of the tip of the blade and the actual velocity of the wind. If both the tip speed and wind speed is the same, the ratio is 1. The current big wind turbines are achieving ratios of 6 or 7. The largest blade size is approaching 200 ft in length.

iii. Transmission

One of the challenges of wind power is connecting the erratic power production of wind turbine to the national grid. A wind farm can be up and running within a year while transmission lines can take 4-5 years to construct. Managing over production times with under production times is a challenge. Grid stability is very important and it raises challenges when a system has huge fluctuations in production.

Advantages of Wind Energy

Wind energy is one of the cleanest sources of renewable energy. No hazardous waste, no vapor/emissions and minimal environmental impact. Furthermore, the ground underneath the wind turbine can be used for agriculture, grazing and other uses. Wind is available all across the globe and every country has the potential to produce wind energy. Its technology is readily available and multiple countries are constructing them under license which lessens reliance on a select few providers. It is also not a protected technology like Nuclear.

Challenges of Wind Power

Wind power is intermittent power source. It is a non-dispatchable source of energy which means that it cannot be turned on or off on demand because wind cannot be controlled by operators like gas, oil or hydropower can be. Grids must be able to quickly compensate for sudden loss of power production by either creating large scale storage capacity or depending on widely dispersed (geographically) wind farms. Usually electrical needs are highest during working hours, is also the time the winds are usually at their lowest speeds. Similarly the wind is slower during summers when electricity needs are highest for the year. So there can be discrepancy between need and availability.

Some of the highest quality wind resources are located in far off & inhospitable areas. The cost of construction and maintenance of large wind turbines in those areas, and the distance of transmission to the central grid can become costly. Wind turbines in inhabited areas can be noisy but newer technology is minimizing the noise production and many new turbines are less noisy than many ordinary vehicles or machines at work. The impact on birds was a concern but studies show that wind turbines kill 20 times fewer birds per unit of energy compared to fossil fuel power plants.

Potential of Wind Power In Pakistan

Major wind resource areas in Pakistan

Southeastern Pakistan especially

- *Hyderabad to Gharo region in southern Indus Valley*
- *Coastal areas south of Karachi*
- *Hills and ridges between Karachi and Hyderabad*

Northern Indus Valley especially

- *Hills and ridges in northern Punjab*
- *Ridges and wind corridors near Mardan and Islamabad*

Southwestern Pakistan especially

- *Near Nokkundi and hills and ridges in the Chagai area*
- *Makran area hills and ridges*

Central Pakistan especially

- *Wind corridors and ridges near Quetta*
- *Hills near Gendari*

Efforts of Pakistan Meteorological Department

Wind Energy is clean & renewable source of energy and is also the world's fastest growing energy resource.

Pakistan Meteorological Department (PMD) with the financial collaboration of Ministry of Science & Technology (MoST), has completed its project entitled "Wind Power Potential Survey of Coastal Areas of Pakistan (Phase-I)" in June 2005.

Phase-II consisting of Wind Mapping of Northern Areas of Pakistan is own going since July 2005.

The demand for energy has increased in tremendous proportions in the last few decades in Pakistan; the same is expected to increase further in the coming years. The primary sources of energy available in Pakistan are oil, natural gas, hydro and nuclear Power. At present oil accounts for approximately 45% of total commercial energy supply. The share of natural gas is 34% while that of hydel power remains roughly at 15%. The increase in cost of fossil fuel and the various environmental problems of large scale power generation have lead to increased appreciation of the potential of electricity generation from non-conventional sources.

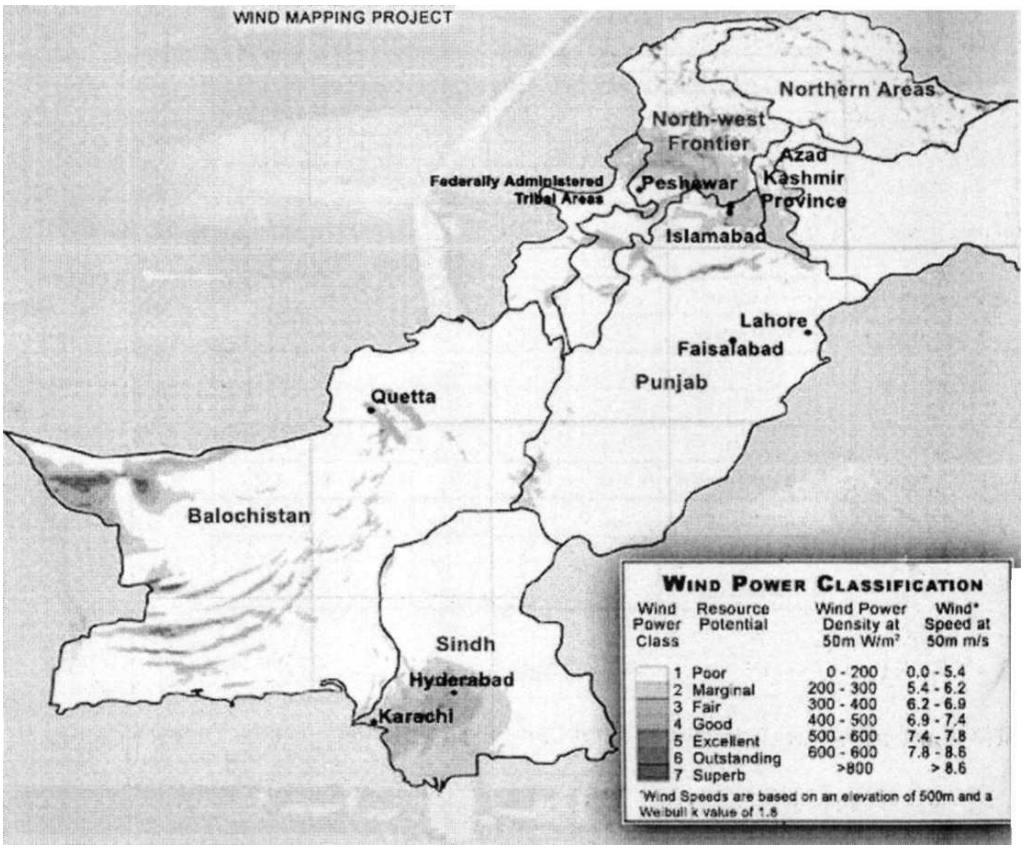

Fig: 1: Wind Mapping Project - Pakistan Meteorological Department

Potential of Wind Power In Pakistan

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Months	Karachi	Ormara	Jivani	Pasni
January	2.5	3.1	4.2	5.0
February	3.4	3.4	5.0	5.6
March	4.0	5.0	6.0	6.5
April	4.2	6.5	5.3	8.5
May	5.0	5.3	5.3	7.7
June	5.9	5.8	6.2	7.6
July	5.4	5.8	5.3	6.5
August	5.0	4.4	5.9	6.7
September	4.6	4.3	5.2	6.9
October	3.5	3.7	4.3	5.9
November	2.3	3.8	3.8	4.2
December	2.0	3.2	3.5	3.9
Maximum	5.9	5.8	6.2	8.5
Minimum	2.0	3.1	3.5	3.9
Annual	3.5	3.6	5.0	6.3

Table: 1

Monthly mean, maximum, minimum and annual wind speed for coastal locations of Pakistan, in in-sec^{-1}

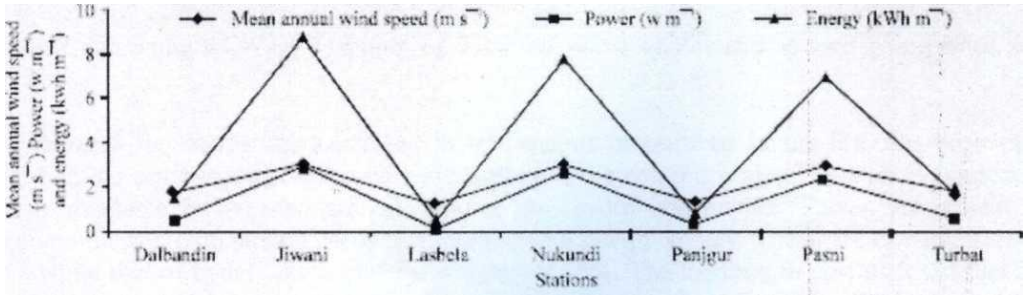

Fig: 2 Mean Annual Wind Speed

Mean annual wind speed for different stations

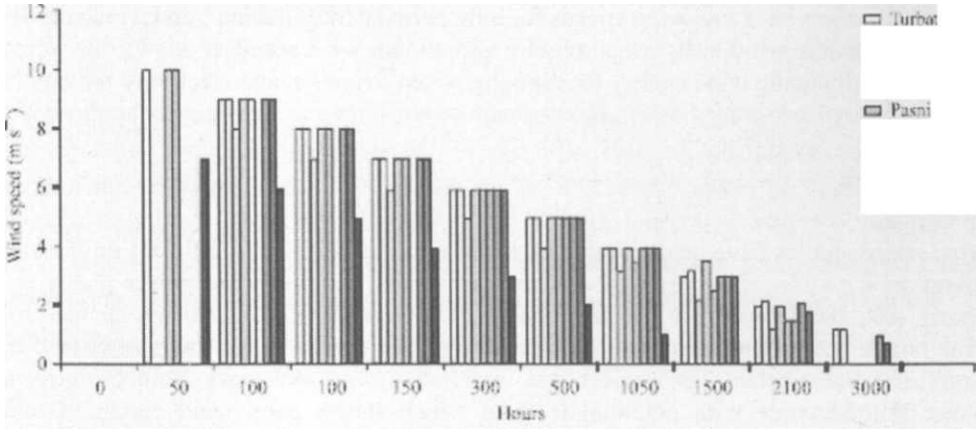

Fig: 3

Wind speed of Costal area of Balochistan. Quetta, Pakistan

Mean annual wind speed for different stations

S.No.	Station	Mean Annual Wind Speed (ms^{-1})	Power (wm^{+1})	Energy ($kWhm^{+1}$)
1.	Nukdi	3.0	2.7	7.9
2.	Lasbela	1.2	0.2	0.6
3.	Turbat	1.8	0.6	1.8
4.	Dalbadin	1.7	0.5	1.5
5.	Jiwani	3.1	3.0	8.8
6.	Pasni	2.9	2.4	7.0
7	Panjgur	1.4	0.3	0.9

Table 2

Summary

Our analysis of wind speed and wind energy distributions in different coastal areas of Balochistan, Pakistan is represented. Some areas are exposed to winds of high speed most of the time while others have low wind speeds for long periods. Sites having good wind speeds are very useful for modern wind mills which require a minimum wind speed. If wind mills were installed in the high producing wind energy for drinking water, irrigation and electricity for small houses.

Conclusion

Wind speed studies have been completed to find the feasibility and efficient utilization of wind energy as a source of energy in Pakistan. Pakistan is building wind power plants in Jhimpir, Gharo, Keti Bandar and Bin Qasim in Sindh. The government of Pakistan decided to develop wind power energy sources due to problems supplying energy to the southern coastal regions of Sindh and Balochistan. The project was undertaken with assistance from the government of China. Another area with potential is Swat which shows good wind conditions and whose traditional leader of Swat (princely state), Miangul Adnan Aurangzeb works with investors interested in wind power investment there once local political conditions improve.

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