

Wind Energy in Egypt

Windenergie in Ägypten

Ashour Abdel Salam Moussa, NEW & Renewable Energy Authority (NREA), Cairo - Egypt

1. Background

In Early 1980's , the Egyptian Ministry of Electricity & Energy has formulated its national strategy in the field of New and Renewable Sources of Energy (NRSE) as an integral part of its global energy strategy. The strategy targeted to supply 5 % of the country's total primary needs, from NRSE by the year 2005. The Priority has been given to Wind, Solar and Biomass.

Wind Energy utilisation was promoted to occupy the top of NRSE priorities . This fact was a result of the national wind resource assessment programme based upon 65 measuring stations, which proved the abundant wind Energy potential at the western coast of the Gulf of Suez, that reaches 20000 MW. Moreover the North coast of Egypt, South Sinai enjoys appropriate resources, East Oweinat and Gelf Ridge enjoy a high potential that can reach 80000 MW. The Red Sea Coast at Zafarana was selected for establishment of large scale Wind farms.

The ambitious Egyptian programme was set up and includes the establishment of a large scale wind farm in Zafarana of a capacity of 600 MW by year 2005, to be build in successive phases with each phase having 60 MW capacity. New and Renewable Energy Authority (NREA) planed that 300 MW shall be financed by the state budget, while the private sector, local and foreign investors, are encouraged to finance the other 300 MW based on Build , Own, Operate and Transfer (BOOT) system.

2. Wind Energy Resource

Coastal zones in Egypt enjoy high wind Energy potential. The Red Sea coast particularly at the Gulf of Suez is one of the highest windy areas of the world.

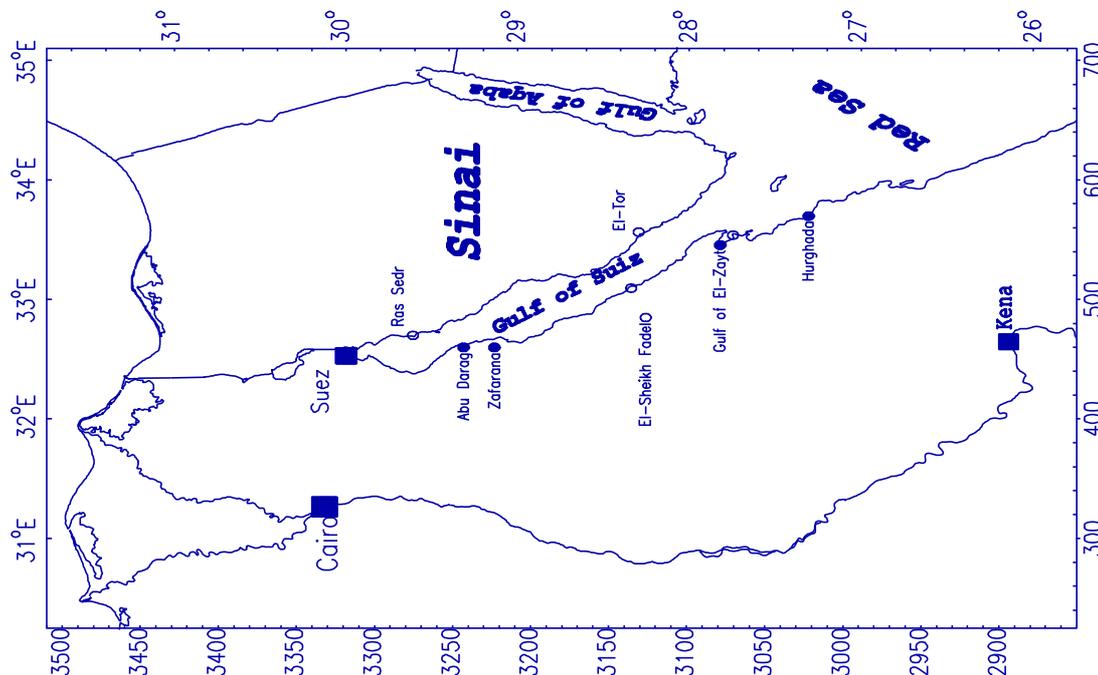


Fig. 1: Overview map for the Gulf of Suez in Egypt

The coast between Abu-Darag and Hurghada has the most favourable wind condition in Egypt with average wind speeds between 7-12 m/s . The land is desert area, and although part of this area is being developed to be a touristic resort, large areas of land are available for wind projects at almost negligible coast.

An overall summary of the wind climates measured at four main stations is given in Table (1). The stations are listed from north to south; Abu Darag, Zafarana and Gulf of El-Zayt are situated along the Gulf of Suez, Hurghada in the northernmost part of the Red Sea.

Station	R [%]	A [m/s]	k	U [m/s]	E W/m ²	D _U [deg]
Abu Darag	75.7	10.3	3.75	9.0	627	358
Zafarana	77.0	10.4	3.42	9.1	652	001
Gulf of El-Zayt	97.7	12.2	3.84	10.6	1016	327
Hurghada	67.3	7.8	2.36	6.9	333	339

Tab. 1: Overall summary 1991-95 of wind observations 24.5 m a.g.l. at the four main stations: data recovery rate (R), Weibull A- and k-parameters, mean wind speed (U), mean energy density (E) and direction (D_U). The occurrence of calms at all four stations is less than 0.1%.

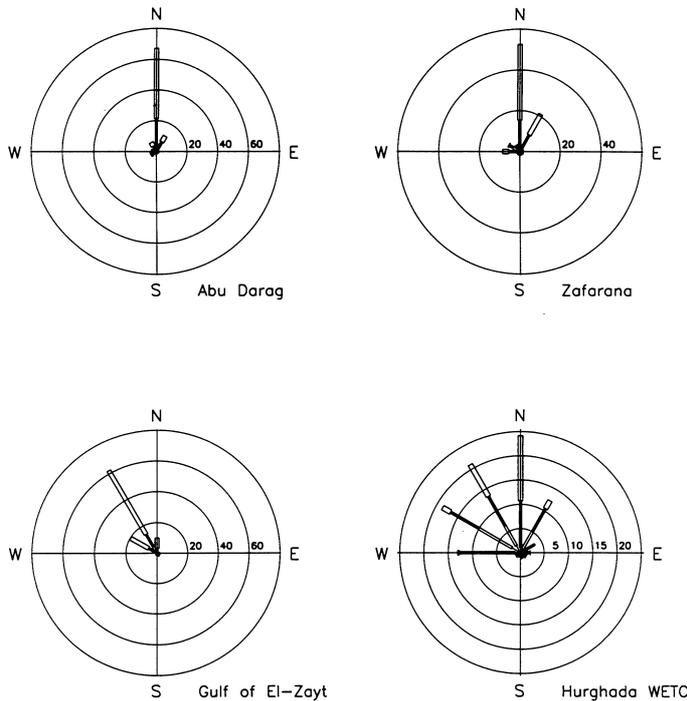


Fig. 2: Wind roses for the stations. Wind direction is shown in twelve 30 sectors and the distribution of mean wind speeds U in each sector is given in four classes: 0 ≤ U < 3, 3 ≤ U < 6, 6 ≤ U < 9, 9 ≤ U, m/s.

density only about one third of the mean values measured at Gulf of El-Zayt. The winds are still steady.

A wind Atlas for the Gulf of Suez Coast were issued in 1997. Moreover the Wind Atlas for Egypt is currently being prepared by both the New & Renewable Energy Authority (NREA), the Egyptian Meteorological Authority (EMA) and RISØ National Laboratory. It is planned to be published this year.

3. Wind Energy Projects in Egypt

3.1 Wind Energy Demonstration

The first wind energy demonstration wind farm was established in Ras Ghareb on the Red Sea coast, with 400 kW capacity. In addition, a 5.2 MW wind farm in Hurghada is operating successfully containing different designs and sizes of wind turbines (100-300KW, see Fig. 3). The wind farm is connected to the local electricity grid of the city and produces more than 15 million kWh/year. The wind farm was established in different stages as follows:

The measured wind distributions at Abu Darag and Zafarana, which are situated a little more than 18 km apart, are very similar - resulting in almost identical mean wind speed and mean energy densities. The wind climate in this area is steady, with respect to both wind speed and direction.

The wind climate at the Gulf of El-Zayt station, which is situated at the entrance to the Gulf of Suez about 160 km to the South, exhibits the same general characteristics as described above. Here, however, the Weibull A-parameter is somewhat higher, leading to a higher mean wind speed and, in particular to a mean energy density which is about 40% higher than Zafarana area.

Leaving the Gulf of Suez and entering the Red Sea, the wind climate changes significantly the character over the 60 km stretch between Gulf of El-Zayt. the mean wind speed at Hurghada is only about two thirds and the energy

- 6 x 300 kW Nordtank (Danish) , erected by 95
- 20 x 100 kW Wincon (Danish) , erected by 94.
- 10 x 100 kW Ventis (German) , erected by 93
- 4 x 100 kW Wincon (Danish) , erected by 92

3.2 Electrification and Water Pumping Using Wind Energy

NREA has started the implementation of autonomous wind/diesel systems for electrification and pumping water in remote areas along the Northern coast. The project consists of 5 demonstration wind/diesel systems to supply clean energy to five small villages, each system consists of 6 wind turbines of 25 kW each + 2 diesel units each 100 kW to supply 3000 kWh/day.

3.3 Large Scale Wind Energy Development Plans

Egypt has crossed the phase of limited experimental project to the phase of grid connected large scale wind farms. A presidential decree has allocated an area of 80 km² on the Gulf of Suez at Zafarana site for NREA as an institutional support and governmental commitment to the wind energy programme.

The on-going activities can be summarised as follows:

- 60 MW wind farm at Zafarana in co-operation with the Danish governmental agency
The project is under implementation, in two phases, each phase is 30 MW, the first phase was contracted in December 1998, and the second phase was contracted in December 1999, and the project is under implementation.
- 60 MW wind farm at Zafarana in co-operation with KfW (Germany)
The first phase 33 MW was contracted in May 1999 and it is under implementation, while the next phase is expected to be contracted this year.
- 120 MW wind farm at Zafarana in co-operation with Japan
The feasibility study was performed for the project.
- 60 MW wind farm at Zafarana in co-operation with Spain
A memorandum was signed with the selected Spanish consulting company to contract consulting services.

4. Economic, Social and Environmental Impact as Result of Wind Energy Projects in Egypt.

- The Crude oil exports is one of the national income of Egypt, therefore the fuel saving can provide an increase in the national income by providing the foreign currency due to oil exportation.
- Increase job opportunities and help solving the unemployment problem, that positively affect the general economic situation in Egypt.
- New community is going to be established in the vast desert area in Zafarana, that enhance local migration of population from the Nile valley to the Gulf of Suez. This is still a problem of population distribution in Egypt.
- The Zafarana wind farm has very effective and positive environmental impact, the operation of the 600 MW wind farms will produce 42,000 million kWh all over their 20 years life time, that in turn will save 10 million tons oil equivalent and will abate the emission of the following quantities of green house gases: 588 Mio ton Cox, 2.1 Mio ton Nox, 8.4 Mio ton Sox

5. Conclusion

Egypt's Red Sea Coast region has two natural resources , land and strong wind in enormous supply. The land and wind are essentially free. The private sector can be encouraged to participate in establishment of wind farms in Egypt under BOOT concept.

6. References

1. Abdel-Kawy Saleh, Laila. Wind Energy in Egypt, Strategy, Program and Projects. New & Renewable Energy Authority, 1999.
2. Country profile and activities for Renewable Energy Development. New & Renewable Energy Authority.
3. Said, Usama; Mortensen, N.G.. Wind Atlas for the Gulf of Suez-1991-95