

Wind Energy in Morocco Potential - State of the Art - Perspectives

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1. Introduction

In 1986, the Moroccan Renewable Energy Development Center (CDER) published the Wind Atlas of Morocco including wind data collected from the meteorological instruments set up in 17 stations and airports in Morocco (1). In 1990, the Center launched a special wind measuring programme. The programme's purpose was to evaluate Morocco's wind energy potential and to find out its best sites. The programme, which compared data collected from sites in different Moroccan regions with airport data, confirmed that Morocco has an important wind energy potential. For example, instruments installed at a 10 m level measured the following annual average wind speeds:

- 8 to 11 m/s in the Tanger and Tetouan region (North of Morocco)
- 7 to 8.5 m/s for Dakhla, Tarfaya, Taza and Essaouira

2. Wind Evaluation Programme in Morocco

A special wind energy evaluation programme was launched in 1990 in collaboration with the Special Energy Programme (SEP) financed by the German Office for Technical Cooperation (GTZ). Its first phase (1991 -1994) served to evaluate the Moroccan wind potential all along the 3500 km long Atlantic coast (from Dakhla/South to Tanger-Tetouan/North). In March 1995, CDER published the report "Le Gisement Eolien du Maroc" (2), containing all the data collected by CDER. In the mean time, the Center published the data for Morocco's best site (having an annual average wind speed of 10.94 m/s at a 9 m level).

The actual second phase (1995-2000) examines Morocco's wind potential in the North-East (Taza, Nador and El Hoceima near the Mediterranean coast) and in its South (Essaouira, Laâyoune and Tarfaya). E.g., Tarfaya has an annual average wind speed of 7 m/s at a 10 m level.

TERNA Programme (GTZ/CDER)

The aim of this supraregional measurement project financed by the German GTZ is to evaluate the wind potential of selected sites in the Essaouira, Tarfaya and Laayoune region, by setting up on these sites 40 m long pylons equipped with calibrated anemometers at heights of 10, 20 and 40 m. These prospective windfarm sites were chosen with a DEWI-expert in October 1997. The anemometers were calibrated by DEWI and will be installed in January 1998.

3. Windfarm Projects in Morocco

3.1 Windfarm Project of 50 MW

From July 1992 to April 1994, CDER set up about 12 dataloggers on different sites in the North of Morocco, from Asilah (40 km south of Tangiers) to Fnidek (37 km north of Tetouan). Al Koudia Al Baida proved to be the best site, with an annual average wind speed of 10.94 m/s at 9 m and a maximum of 36.5 m/s. On the basis of these measurements, CDER worked out the feasibility studies for two windfarms: one of 50 MW and one of 3 MW.

The 50 MW windfarm is a private project (BOT contract) between TRAMONTANA (France) and VESTAS (Denmark). Morocco's State owned utility company (ONE) committed itself to buy all the power produced by this windfarm within a period of 19 years. The project contract was signed on November 3rd, 1997; construction will start in 1998 and electricity production is scheduled for 1999. Power will be generated by 84 VESTAS V42-windturbines with a capacity of 600 kW. The total windfarm area will cover about 270 ha. Production is estimated at 225 GWh and should supply the national grid. One kWh produced will cost approx. 0.30 to 0.40 DH (1DM = 5.5 DH). Total project costs amount to US\$ 64 millions, and are supported jointly by the French utility company EDF (49 %), the Paribas Merchant Bank (35.5 %) and the French consultancy GERMA (15.5 %).

The project should cut each year fuel oil imports by 46,000 tonnes, thus saving US\$ 10 millions, and avoid emission of 200 million tons of carbon dioxide.

3.2 Windfarm ONE/KfW of 3.5 MW

The 3,5 MW-project is co-financed by the German KfW and the Moroccan ONE, and will equally be constructed on the site of Al Koudia Al Baida. Annual production is estimated at 12 GWh. The project costs amount to approx. 10.5 million Deutsche Mark (KfW will contribute by 8.5 million DM). Each year, the project should cut fuel oil imports by 2761 tons, thus saving 4.8 million US\$.

3.3 Windfarm Project of 200 MW

This new 200 MW-project plans the construction of 3 more windfarms: two of them in the North of Morocco (75 MW in Dhar Sadane and 65 MW in Sendouk / Tangiers region) and one of them in its South (60 MW in Tarfaya). The annual average wind speed measured at a 10 m level on different sites near Tangiers was situated between 8 and 9 m/s, and in the Tarfaya - Essaouira region between 7 and 8 m/s. Invitation to tenders is expected for 1998.

3.4 Windfarm Project of 2.8 MW

This project will be totally financed by ONE. Its objective is to set up test windturbines on different sites along the Atlantic coast from Essaouira to Dakhla, in order to decide if and where to build further windfarms. It is planned to set up:

- 2 wind turbines of 500 kW in Essaouira
- 1 wind turbine of 500 kW in Tan-Tan
- 1 wind turbine of 300 kW in Tarfaya
- 1 wind turbine of 500 kW in Laayoune
- 1 wind turbine of 500 kW in Dakhla

4. Conclusion

These projects form a part of the Moroccan energy strategy to develop renewables (Photovoltaic, Biomass, Thermal Solar plant,...) and move away from conventional polluting fuels and hydro power limited by years of drought.

5. Literature

- [1] Le Gisement Eolien du Maroc – (CDER) - 1995
- [2] L’Energie Eolienne au Maroc – (CDER) – 1986

6. Annex

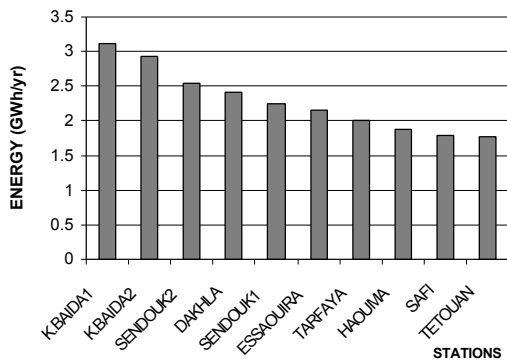


Fig. 1: Energy estimate by Alwin for different sites (Enercon E40 - 500 kW Hub. Height: 43.5 m)

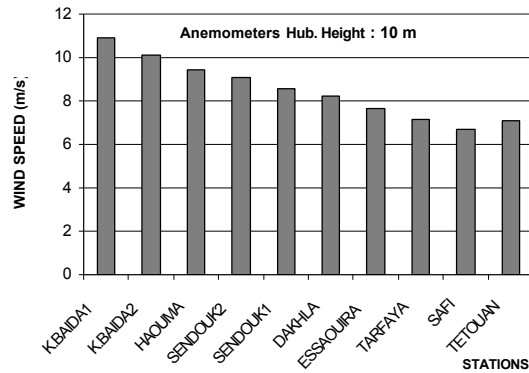


Fig. 2: Annual average wind speed sites in Morocco

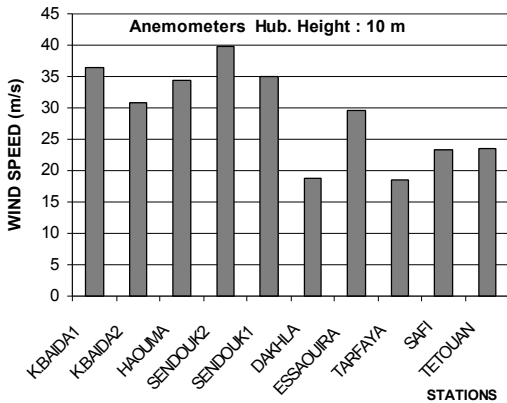


Fig. 3: Maximum wind speed sites in Morocco

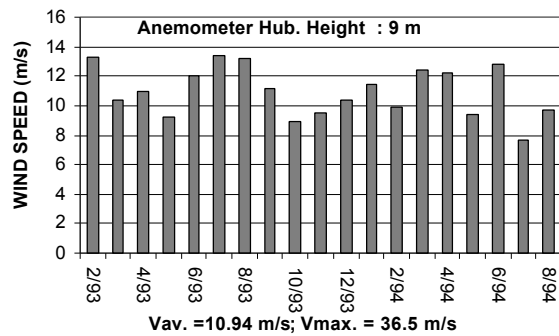


Fig. 4: Results for the site Koudia Al Baida (wind speed)

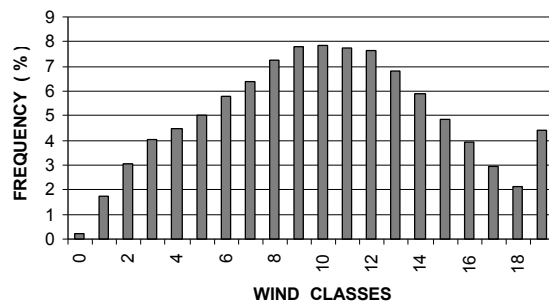


Fig. 5: Results for the site Koudia Al (frequency distribution)