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## WIND ENERGY IN TURKEY

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### ABSTRACT

Wind and wind energy has always played an important role in the historical and economical development of Asia Minor and the geographical area covered by the Republic of Turkey today. The ancient city of Troia probably became rich with harbor fees from commercial vessels, which could not sail up the Dardanelles because of strong north-easterly winds and swift currents. As early as 1389 AC wind mills were already dominant landmarks and found their way even into naval maps. In 1940's wind mills ground corn, pumped water to fields and even powered first radio sets at the Anatolian country side. Like elsewhere, with the onset of oil era and construction of large hydroelectric and fossil fuel power plants this renewable energy source was forgotten in Turkey until recently.

Today there is a serious intention on part of Turkish authorities to promote wind energy. The Ministry of Energy and Natural Resources approved the first B.O.T. wind park with 12 x 600 kW turbines in December 1997 and the contract text was initialled on April 3, 1998. By the time we present this paper this wind park should be in operation along with the first Autoproducer wind park with 3 x 500 kW turbines, which was connected to the grid on February 20, 1998. Efforts to include wind energy also in the B.O.O. Law are also continuing.

We at Interwind estimate the usable wind energy potential in Turkey, at around 8'000 MW. However, how much of this potential can be utilized in the near future will depend on three factors;

- 1) Definition of the specific place of renewable energy sources in the overall energy politics of Turkey,
- 2) Reinforcement of infrastructure at high wind locations as a matter of priority,
- 3) Revision of legal frame work for independent power producers to address the realities of the present and demands of the future. © 1998 Published by Elsevier Science Ltd. All rights reserved.

### KEYWORDS

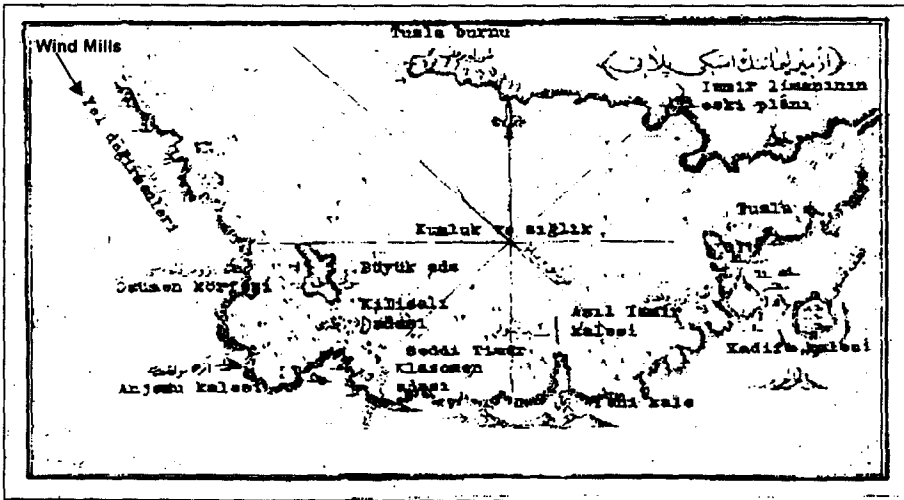
Wind Energy; Potential; Turkey; Troia; Legislation; Autoproducer; B.O.T.; B.O.O.

## WIND ENERGY IN TURKEY

1500 BC - 1960 AC

Wind and wind energy has always played an important role in the historical and economical development of Asia Minor and the geographical area covered by the Republic of Turkey today. The earliest documented evidence of this statement goes back to the ancient city of Troia. Negotiating the narrow strait against the wind and the strong current was a difficult, sometimes impossible task. Once the strong north-easterly winds started to blow, they could hold ships in the harbor of Troia sometimes as long as 45 days. Possibly the Troia ".... exploited its situation close to the southern entrance to the Dardanelles by exacting dues from ships that were forced to tarry for favorable winds to sail northward ...." (Neumann, 1991<sup>1</sup>).

We do not know when the first wind mills were installed in Anatolia. However they must have been dominant landmarks already in the 14<sup>th</sup> century. A naval map dated 1389 AC shows wind mills as landmarks along with the shallows and sand banks in the Bay of İzmir. (Figure 1).



**Fig. 1:** Bay of İzmir in 1389. Wind mills - "Yel değirmenleri" - are already dominant landmarks (Naval Map at Faculty of Marine Sciences, 9 Eylül University, İzmir)

The numerous ruins of wind mills, particularly on the west coast of Turkey indicate the important role of wind energy in the economic development of the area. In Alaçatı - İzmir many inhabitants can still remember bringing their corn to these mills (Figure 2). In 1940's wind mills ground corn, pumped water to fields and even powered the first radio sets at the Anatolian country side as reported by elders of the author of this article.



**Fig. 2:** Restored ruins of wind mills in Alaçatı - İzmir. 7.2 MW B.O.T. project developed by Interwind is situated on the hill seen at the right hand side of the picture. (Photo by Interwind)

### 1960 - 1993

A survey by the Turkish Ministry of Agriculture in the years 1960-1961 recorded 749 wind mills, of which 718 were used for water pumping and 41 for electricity production. 5 years later, another similar survey revealed only 309 units, of which only 2 were producing electricity. Increasing oil prices during 1973-1978 had obviously an impact. 1978-1979 survey revealed 871 water pumping and 23 electricity producing turbines. Unfortunately this survey did not record how many of these turbines were actually in operation. In any case all of them were below 1 kW power. (Ültanır, 1996<sup>2</sup>). Except for very few these turbines have disappeared.

Since 1980's several universities have worked on wind energy, while TÜBİTAK Marmara Research Center has started with studies towards developing a Wind Atlas for Turkey. E.İ.E., the General Directorate of Electrical Power resources Survey and Development Administration, of the Ministry of Energy and Natural Resources has been measuring wind at several locations and has installed a 1.1 kW test turbine. In October 1984 the first "modern" wind turbine, a 55 kW Vestas unit was installed at a holiday resort in Çeşme - İzmir. In 1992 the predecessor of the Turkish Wind Energy Association (TWEA) was established as a branch of the European Wind Energy Association.

It is understandable that the use of wind energy in Turkey declined until 1980's like elsewhere. The onset of oil era and construction of large hydroelectric and fossil fuel power plants provided abundant and cheap energy. Why was then the rebirth of wind energy in Turkey, a country with vast wind resources, delayed until now? The reason only becomes obvious if one understands the realities of energy politics in a rapidly growing economy.

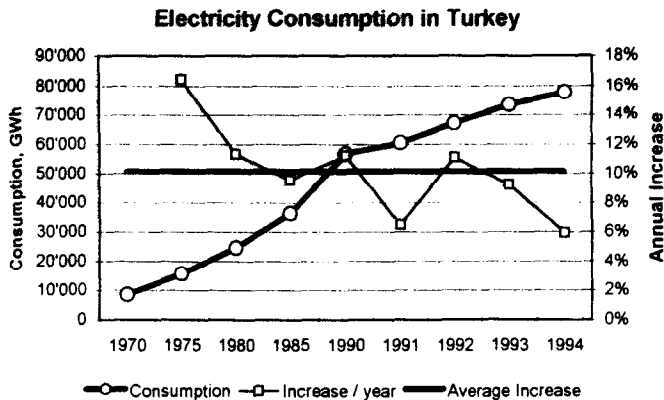


Fig. 3: Development of electricity consumption in Turkey during the last 25 years. Average annual increase is 10.2% (TEAŞ, 1994<sup>3</sup>).

While wind energy started to make its come back in the U.S. and western European countries in early 1980's, the Turkish state, the only power producer in Turkey at that time, was struggling to answer a demand for electricity, which grew at an average rate of 10% every year (Figure 3). Legal frame work for independent power producers was, and still is, totally outdated. Local and foreign investors, except for the most powerful and persistent, are reluctant to invest in energy projects. Existing laws treat power plants in a totally indifferent manner, where the only criterion is the cost per kWh. Although never officially admitted the state subsidized production of power by the state owned monopolist T.E.K. (Turkish Electricity Board). Consequently private investors were offered unrealistically low kWh prices. T.E.K. was reorganized in 1994, as TEAŞ, which is responsible for power production and transmission down to 60 kV level and TEDAŞ, which is responsible for transmission at 34.5 kV level and distribution.

#### 1994 - 1997

In 1994 Interwind presented to the Ministry of Energy Project TALEN (Interwind, 1994<sup>4</sup>). This was the first B.O.T. feasibility study for a wind energy project in Turkey. The original idea was to build an 18 MW wind power plant on the island of Bozcaada on the west coast of Turkey, consisting of thirty 600 kW units. The project was revised at the end of the year, since the high-voltage line from the island to the main land had a maximum capacity of 7.8 MW. In this revised version we also pointed out several other locations, such as Karabiga, Hatay-Şenköy and İsparta as potential sites. Later we shall see that this information played an important role in the development of the current wind energy scene in Turkey.

This report released a sudden burst of activity by various Turkish entrepreneurs. By April 1996 we were aware of 10 projects for some 475 MW and had heard of 5 others of undefined installed power. Soon it was obvious that the Turkish Wind Energy Scene was facing three serious problems; a) bazaar style negotiable power purchase prices, b) complexity of legislation for independent power producers, c) lack of clear policies for renewable energy projects. The most

important handicap of the latter problem was and still is the unavailability of international arbitration, a major issue for foreign investors. The Turkish wind energy enthusiasts had two choices; wait until the legislation becomes favorable or operate under existing legal frame work, which allows three types of electricity production schemes for an independent power producer:

- 1) Autoproducer: for organizations producing their own electricity to cover their own needs. Economically it only works if the organization consumes the total production, because pricing structure discourages sales of excess electricity to TEAŞ / TEDAŞ (about 3 cents/kWh). This scheme does not make any distinction in the primary power source.
- 2) B.O.O.: Build-Own-Operate scheme is operative only since summer 1997 and excludes hydro and nuclear-power and renewables as of yet
- 3) B.O.T.: The general outline of the Build-Own-Operate scheme dates back to 1984 and is the only scheme, which foresees renewables. This scheme's complexity arises from the fact that it is a state contract and as such subject to approval of Danıştay, the Turkish Supreme Council, the Administrative Court.

The decision was unanimous; we all decided to start working without delay. Simultaneously TWEA stepped up its activities in promoting wind energy at all levels of the political system.

One company, Demirer Holding, decided to build a small Autoproducer wind park, to get familiarized with the technology and demonstrate the state of the technology to the authorities. In spring 1997 they turned in their feasibility report for a 1.5 MW wind park.

Having no production plant to consume the produced power Interwind had to work under the B.O.T. scheme. We turned in a feasibility report to the Ministry of Energy for a 7.2 MW wind park in Alaçatı - İzmir in October 1996.

## 1998

By January 1998, there were 25 applications for wind energy projects on record at the Ministry of Energy, for a total of 670 - 1'440 MW installed capacity (DETAY 1998<sup>5</sup>). Remarkably many of these projects target sites initially indicated by Interwind; Bozcaada (5 MW), Hatay (150 MW), Karabiga (70 MW). The area favored most is the Çeşme Peninsula. Wind measurements conducted since 1994 by a single individual, Mr. Ergün Özakat, imply an annual average of 7.4 m/s at 10m above ground. In Turkey such news travel fast, 750 MW of the above mentioned 1'440 MW, including the already approved Autoproducer and BOT projects are in this area.

However, it will certainly not be possible to install so many wind turbines on Çeşme Peninsula in the near future, since the 80 km long, 157 kV high voltage line will realistically carry a maximum of 60 - 90 MW. Even with the best intentions it may take TEAŞ several years to plan and build additional high voltage lines to carry 750 MW of wind power, provided that they start allocating necessary resources now.

In spite of this on February 20<sup>th</sup>, 1998 the 1.5 MW Demirer Autoproducer wind park was connected to the grid after almost a year's worth of paper work and negotiations in spite of the simplicity of the Autoproducer scheme (Wind Power Monthly, 1998<sup>6</sup>).

On April 3, 1998 Interwind initialled the first wind energy B.O.T. contract for a 7.2 MW project. It took 6 months to move from initial application to feasibility report stage, additional 5 months to negotiate the power purchase prices and another 8 months to negotiate contract terms. We hope to have this wind park in operation by the time this paper is presented.

### The future

Turkey has coast line of 8'000 km. Assuming that one can install 1 MW / km, we estimate the wind energy potential in Turkey at these prime locations at around 8'000 MW. This estimate does not take into account several inland sites, which may have equally favorable conditions.

However, how much of this potential can be utilized in the near future will depend on three factors;

- 1) Definition of the specific place of renewable energy sources in the overall energy politics of Turkey,
- 2) Reinforcement of infrastructure at high wind locations, as indicated by Ministry's own measurements and the activities of private investors, as a matter of priority,
- 3) Revision of legal frame work for independent power producers to address the realities of the present and demands of the future.

Today there is a serious intention on part of Turkish authorities to promote wind energy. Lobbying to include renewables, particularly wind energy, in the B.O.O. scheme is continuing. In March 1998 the cabinet cleared one of the most serious obstacles in the way of wind energy projects; the 5.5 % up-front fee charged by the Ministry of Forestry. The authorities are beginning to understand the potential of wind energy, the state of its technology and its possible contributions to the national economy. There are indications that the matter of the foreign arbitration issue may also be resolved in the near future (Tonge 1998<sup>7</sup>).

All these developments lead us to believe that Turkey will become THE wind energy market in the coming decade.

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<sup>1</sup> Neumann, Jehuda (1991), Number of days that Black Sea bound sailing ships were delayed by winds at the entrance to the Dardanelles near Troy's site, *Studia Troica* 1.1991, 92-100,

<sup>2</sup> Ültaır, Mustafa Özcan (1996), Yel değirmenlerinden günümüze rüzgar enerjisi, *Skylife*, inflight magazine of Turkish Airlines, April 1997, 56-61

<sup>3</sup> TEAŞ (1994), Turkish Electricity Generation Transmission Co., Annual Report 1994, p 24

<sup>4</sup> Interwind (1994), Project TALEN, Feasibility study for an 18 MW B.O.T. wind park on the island of Bozcaada

<sup>5</sup> DETAY (1998), DETAY Weekly Economic Magazine, Tenders Review, Energy Ministry's Wind Power Plant Projects, January 1998, 147-150

<sup>6</sup> Wind Power Monthly (1998), Turkey's wind market opens, Vol. 14, No. 3, March 1998, p 27

<sup>7</sup> Tonge, David (1998), Modernist policy likely to prevail, *Financial Times*, 31, March 1998