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A COMPARATIVE WIND POWER PLANT FEASIBILITY STUDY FOR GÖKÇEADA, TURKEY

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Abstract

In this study, renewable energy project analysis softwares RETScreen® International and ALWIN are used to analyze the wind data of Gökçeada, Turkey. The annual cumulative wind speed values of Gökçeada applied to these softwares; the system characteristics, annual energy production, power and energy curves of selected wind turbines are obtained as output. The main objective is to indicate the abundant potential of wind power in Turkey.

GÖKÇEADA, TÜRKİYE İÇİN KARŞILAŞTIRMALI RÜZGAR ENERJİ SANTRALİ FİZİBİLİTE ÇALIŞMASI

Özetçe

Bu çalışmada, Gökçeada rüzgar verilerinin analizi için yenilenebilir enerji proje analiz programları RETScreen® International ve ALWIN kullanılmıştır. Gökçeada' ya ait yıllık ortalama rüzgar hız değerleri bu yazılımlara uygulanmış; seçilen rüzgar türbinlerine ait sistem karakteristikleri, yıllık enerji üretimi, güç ve enerji eğrileri çıktı olarak elde edilmiştir. Esas amaç, Türkiye' nin bol rüzgar enerji potansiyelini göstermektir.

Keywords: *RETScreen® International, ALWIN, Wind Energy Project, Gökçeada.*
Anahtar Sözcükler: *RETScreen® International, ALWIN, Rüzgar Enerji Projesi, Gökçeada.*

1. INTRODUCTION

There are large numbers of studies underlining the great potential of renewable energy resources to contribute to Turkey's national energy production. These studies include, among others, Issues and Alternatives of Energy and Environment Report of the World Bank, The Working Group Report on Energy Technology Policies (STRIT/TDFT, 1998), National Environment Strategy and Action Plan, the research activities of the New and Renewable Energy Resources and Technologies Research Unit (NRERTRU) of Kocaeli University and the Energy Department of the Marmara University and the Wind Atlas of Turkey jointly produced by the Electrical Power Resources Surveying Administration (EIE) and State Meteorological Service (SMS). Among the different renewable energies, wind energy is regarded as having the highest potential in Turkey. A recent promising development in this regard is that of the Wind Atlas of Turkey [1], which was jointly prepared by the EIE and the SMS, and published in June 2002. The results of modeling used in the Atlas indicate that the regions with the highest potential for wind speeds at 50 m above the Earth's surface are the Aegean, the Marmara, and the Eastern Mediterranean Regions. The publication of the Atlas is expected to generate an increase in the numbers of interested investors and investments. The Wind Atlas study in Turkey was based on a study conducted by the Department of Mechanic and Energy Systems of Marmara Research Center of the Scientific and Technological Research Council of Turkey (TUBITAK-MAM) in 1999, supported by the State Planning Organization (SPO). [2]

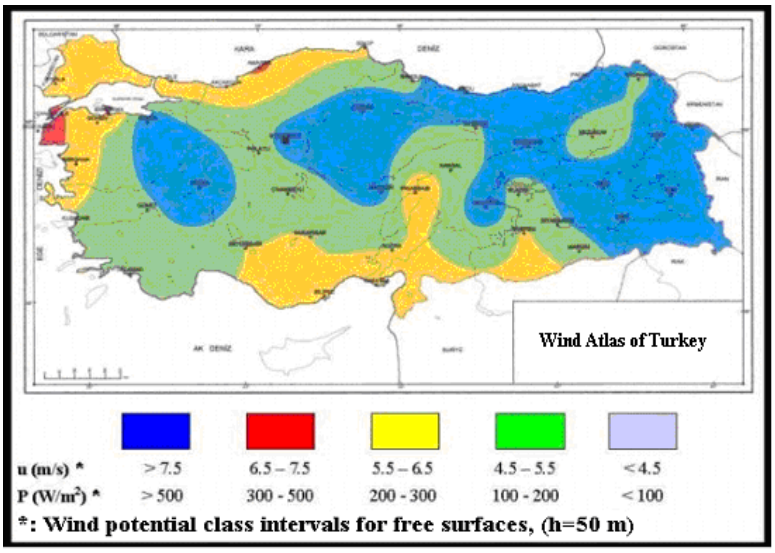

Figure 1: Wind Speed Distribution in Turkey, [1]

TUBITAK-MAM commenced this study for the purpose of preparing a wind atlas for Turkey. In 1989, this research group constituted and published Turkish Wind Atlas Statistisc by the support of SPO [3,4,5,6,7,8,9,10]. The project "Investigation of Wind Energy Utilization Options in Turkey" was initiated and wind turbine prototype construction and test laboratory was founded.

According to the Special Commission on Electrical Energy of the State Planning Organization(2001)[11], the potential is 10000 MW, citing the study of EIE. [12]

2. SITE SELECTION: GÖKÇEADA

In recent years, the Ministry of Energy and Natural Resources (MENR), the Ministry of Environment, the EIE, the Technology Development Foundation of Turkey (TDFT), STRIT, various universities, and research institutes have come together to collaborate for further developing the energy agenda of Turkey. In this point of view, with the

huge potential of wind power, Gökçeada is the biggest island of Çanakkale as well as Turkey. The area of the island is about 289,5 km square. Gökçeada, with an important strategical role also for the Turkish Navy, is located 33 miles away from Çanakkale and 14 miles from Kabatepe sea port of the Gelibolu peninsula.

Table 1 illustrates detailed wind speed records measured by EIE for Gökçeada, Turkey.

Station	Year	1	2	3	4	5	6	7	8	9	10	11	12	Average
Gokceada	1994	7,8	7,4	7,6	6,4	4,5	5,4	8,2	6,1	6,1	7,2	7,4	6,5	6,7
	1995	9,3	7,5	7,7	5,7	6,9	4,6	7,4	6,6	5,3	8,4	6,7	8,3	7
	1996	8,6	8,6	8,1	4,5	5,5	6	7,3	6,4	5,2	6,2	6,9	8,2	6,8
	1997	7,4	7,7	7,7	6,1	F	F	F	F	F	7,8	5,9	7,6	7,4
	1998	5,2	6,4	8,1	7,2	5,8	5,5	6,9	7,7	6,4	6,4	7,7	10	6,9
	1999	7,4	6,7	6,1	5,2	5,8	5,2	7,1	6,6	4,7	6,1	7,4	8,6	6,4
	2000	7,2	6,8											

Table 1. Detailed wind speed records measured by EIE in some specific locations throughout Turkey, [11]

3. WIND ENERGY PROJECT APPLICATION BY RETSCREEN® INTERNATIONAL AND ALWIN

The average of annual wind speed value of Gökçeada, Çanakkale (pointed in circle) in Table 1 above, is applied to two different Wind Energy Modelling Softwares.

As seen in the Figure 2, the first software is Retscreen® International; a standardized and integrated renewable energy project analysis software. This tool provides a common platform for both decision-support and capacity-building purposes. RETScreen can be used worldwide to evaluate the energy production, life- cycle costs and greenhouse gas emissions reduction for various renewable energy technologies (RETs).

RETScreen International is an innovative renewable energy awareness, decision-support and capacity building tool developed by the CANMET Energy Diversification Research Laboratory (CEDRL). The core

of the tool consists of standardized and integrated renewable energy project analysis software that can be used worldwide to evaluate the energy production, life-cycle costs and greenhouse gas emission reductions for various types of RETs. [13]

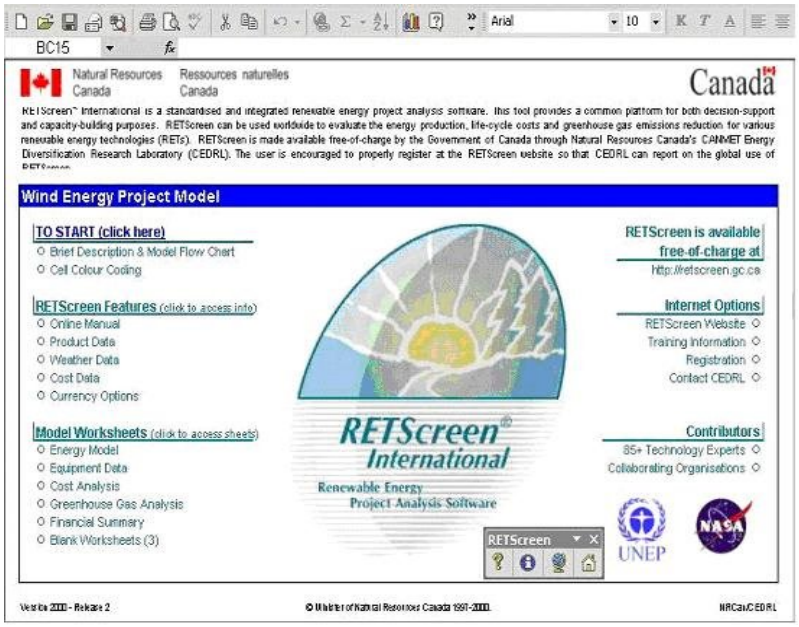

Figure 2: RETScreen® International Wind Energy Project Modelling Software

The second software, ALWIN links the information on the wind potential at a given site with the technical data of a wind turbine in order to predict the possible energy yield. The program presents all data and results in clear graphs and tables and supports the user with an elaborate on-line help facility. ALWIN may be run on PC-compatible computers using Windows. Data characterizing the wind potential of a site are stored in a site file. The user creates this file by either feeding the measured data manually or by importing them from a measurement file as created by Ammonit' s data loggers WICOM or WINDSITER. In order to analyze a fictitious site it is possible to employ the Rayleigh or Weibull distribution specifying the

appropriate parameters. A site file may be changed or updated with new measurement data at any time. The WEC catalog contains the required information of one or more wind energy converters (WEC). This file may be created and edited by the user through input of power curve data, control system information and hub height into given input fields. The power curves are depicted in a special graph and complemented by a table of wind speed versus electric power data as seen in Figure 3.

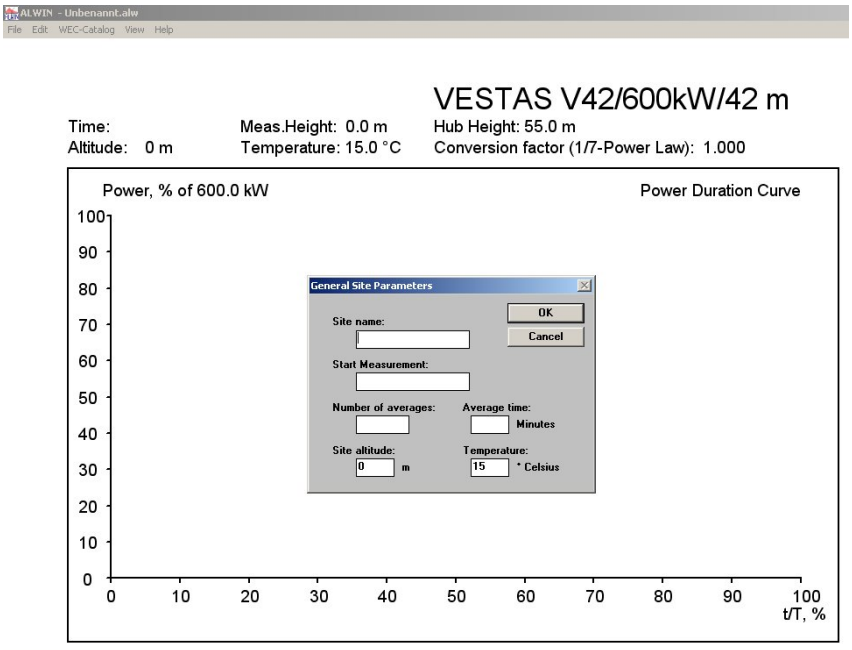

Figure 3: ALWIN Wind Energy Modelling Software

For energy output calculation the site file is to be opened, the desired wind turbine is to be chosen from the catalog and installed with a "double click" on the left mouse button. Energy output, average power performance and capacity factor are calculated in accordance to IEA/IEC standards. The height of wind speed measurement and hub height are taken into account as well as information on the control system and air density. [14]

4. CASE STUDY FOR GÖKÇEADA

The annual wind speed average value of Gökçeada, pointed in circle in Table 1 above, is applied in RETScreen® INTERNATIONAL and ALWIN, respectively. The inputs obtained from selected softwares are the technical data of selected wind turbine model and the wind speed value. The software outputs the power curves and tables of the selected turbine configuration, power prediction diagrams.

These wind farm energy models are planned for different two wind turbine configurations. In the first configuration, 17 turbines of Vestas V42 (Rated Power: 600 kW) take place in the project. The wind farm with 17 x 600 kW generates 10,2 MW electricity. The second project involves 6 turbines of Vestas V66 (Rated Power: 1,65 MW), which equals 9,0 MW electricity generation, which can also supply the total electricity demand of an extensive naval base.

			RESULTS OF RETSCREEN		**RESULTS OF ALWIN**	
Location	Wind plant configuration	Annual Wind Speed Average (m/s)	Wind Plant Capacity Factor	Energy Delivered (MWh)	Wind Plant Capacity Factor	Energy Delivered (MWh)
Gökçeada	V 42 x 17	7.4	44%	39105	47.2%	42131
Gökçeada	V 66 x 6	7.4	42%	36325	44.9%	38947

Table 2. Comparison of the resultant data obtained from RETScreen® INTERNATIONAL and ALWIN software applications

5. CONCLUSION

The comparison of the wind plant capacity factors and the annual energy generation values obtained by these softwares are illustrated in Table 2 above.

Wind plant capacity factors attract attention as in an approximated range; varying 42-44% for Vestas V42 and 49-51% for Vestas V66. The annual energy generation values are also noticed in a close range to each other. The annual energy generation of Vestas V42 calculated by RETScreen® INTERNATIONAL in Gökçeada is 39105 MWh. The same site conditions give the result of 42131 MWh by ALWIN. The fact that should be noted by both software applications is that these locations have a high wind potential and wind power on this site can be extracted with a high efficiency.

REFERENCES

[1] Turkish Meteorology Organization, "*Wind Atlas of Turkey",* http://www.meteoroloji.gov.tr/2006/arastirma/arastirma.aspx?subPg=107&Ext=htm, (August 2007).

[2] Turkish Ministry of Environment, *"National Report on Sustainable Development",* http://www.cevreorman.gov.tr/ekitap/02.pdf (August 2007).

[3] Uyar, T.S., Alpay M. Naci, Yazar A., *"Turkish Wind Atlas Studies for Bodrum, Muğla"*, Proceedings of the European Wind Energy Conference (EWEC 89), Part 2, pp. 906- 910, Glasgow, Scotland, (June 1989).

[4] Uyar, T.S., Alpay M. Naci, Yazar A., *"Turkish Wind Atlas Studies for Gebze, Kocaeli"*, Proceedings of the Fourth Arab International Solar Energy Conference, Oman, Jordan, (November 1993).

[5] Uyar, T.S., *"Regional Wind Atlas Statistics for Sinop"*, Kocaeli University Magazine, No: 1, (1994).

[6] Uyar T.S., YAZAR, A.; Alpay, M. N., *"Çorlu, Uzunköprü ve Kırklareli için Hesaplanan Rüzgar Atlas İstatistikleri"*, TÜBİTAK Project Report No:2, pp:190, MAE, Gebze, Kocaeli, (February 1988).

[7] Uyar, T.S., YAZAR, A., Alpay, M. N., *"Afyon, Seydişehir, Elmalı, Yumurtalık ve Anamur için Hesaplanan Rüzgar Atlas İstatistikleri"*, TÜBİTAK Project Report No:3, pp:301, MAE, Gebze, Kocaeli, (June 1988).

[8] Uyar, T.S., YAZAR, A., Alpay, M. N., *"Bozcaada, Çeşme, Fethiye, ve Sultanhisar için Hesaplanan Rüzgar Atlas İstatistikleri",* TÜBİTAK Project Report No: 4, pp: 148, MAE, Gebze, Kocaeli, (August 1988).
[9] Uyar, T.S., YAZAR, A., Alpay, M. N., *"Hopa, Samsun, Trabzon ve Sinop için Hesaplanan Rüzgar Atlas İstatistikleri"*, TÜBİTAK Project Report No: 5, pp: 148, MAE, Gebze, Kocaeli, (November 1988).
[10] Uyar, T.S., YAZAR, A., Alpay, M. N., *"Ağrı, Gemerek, Çanakkale ve Akçakoca için Hesaplanan Rüzgar Atlas İstatistikleri"*, TÜBİTAK Project Report No: 6,pp: 148, MAE, Gebze, Kocaeli, (December 1988).
[11] SPO, *"Elektrik Enerjisi Özel İhtisas Komisyonu Raporu, 8. Beş Yıllık Kalkınma Planı*", (Special Commission on Electricity Energy State Planning Organization), DPT: 2569, ÖİK: 585, Ankara, (2001)
[12] Electrical Power Resources Surveying Administration(EIE), *"The Wind Projects of EIE"*, http://www.eie.gov.tr/turkce/ruzgar/RGI_AYLIK_HIZLAR.xls, (August 2007).
[13] Retscreen® International, Natural Resources Canada, http://www.retscreen.net/ang/t_software.php,(August 2007).
[14] Alwin Wind Energy Modelling Software, http://www.ammonit.de/english/page2.html, (August 2007).