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Wind Power Plant Feasibility Study in Tokat with RETScreen Analysis Program

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Abstract – As in many countries, external dependence on energy constitutes majority of the budget allocated for energy costs in our country. Recently, in accordance with increasing global warming, the tendency to the renewable energy sources is increasing as well. However, the usage of the renewable energy sources costs very much at present. Therefore, a well-organized feasibility analysis both prevents the producer from a high cost and raises the productivity.
In this study, wind power, with a huge importance among the renewable energy sources in our country, was mentioned and cost, financial, and risk analysis were done for the system with 100 kW in total, 2 turbines; each with 50kW, thought to be established on Taşlıçiftlik Campus in Tokat province by using RETScreen analysis program.

Keywords -
Wind power, Renewable Energy, RETScreen, Tokat.

1. Introduction

Lately, as in the world, the studies related to the evaluation of the renewable energy sources in our country have increased. One of the reasons why these studies have gained momentum is the high waste of natural energy sources like petroleum, coal, and etc. owing to the unconscious usage. Another important reason is that these sources do not cause the greenhouse gase emission done by fossil fuels.

The wind power, among the renewable energy sources, is a clean and economical energy source. Therefore, as in the other countries in the world, the investments in wind power have been increasing. The wind power potential of Turkey has been determined as 48.000 MW [1, 2]. The majority of this rate belongs to Aegean, Marmara, and Mediterranean regions. Black Sea region is at the 5th rank. When Tokat province is taken as reference, a

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RES power station with established 40 MW operated by PEM En Inc. in Tokat in 2015 is available. In addition, Akyurt RES with 12.8 MW and Bereketli RES with 32 MW are on the verge of establishment [3]. When these power stations are taken into consideration, Tokat province has a suitable location for RES.

Figure 1. Tokat Region RES Map

RETScreen is a clean energy packet developed by Canada government as clean energy management software. RETScreen program based on Excel first came into use in 1958. Program has two versions; RETScreen 4 and RETScreen Plus [4]. RETScreen program enables the user to make a pre-study in financial and technical analysis of the designers and decision makers. A feasibility analysis was done for the system to be established by doing cost, emission, and economical analysis for a RES with 1 MW power in Hatay by using RETScreen program before, and such questions as that how sufficient the power station will be and that when the investment will turn into income were answered [5]. A similar study was done for a RES with 4 MW power in Niğde, and the cost and income were calculated by doing financial and economical analysis of the system.

In this study, a feasibility study was done for a wind power system with 100 kW established power on Taşlıçiftlik Campus in Tokat province in accordance with meteorological data taken as references by using RETScreen program. In the feasibility study, financial, economical, and risk analysis were done for the system to be established. As a result of the analysis, a wind power system to make profit after 20 years has been found.

2. Material Method

2.1. RETScreen Analysis Program

RETScreen Clean Energy Project Analysis Software was first brought into use by Canada government CANMET Energy Investigation Lab. This free-use software has two versions as RETScreen 4 and RETScreen Plus. RETScreen 4 based on Excel makes the technical and economical analysis in energy and energy productivity for designers convenient. Traditional energy modelling or cleaner and more economical comparisons can be done in RETScreen program. Users can make energy, cost, emission, financial, and sensibility/risk analysis as five steps through this program. RETScreen Plus based on Excel enables the users to validate the performance in energy applications in their facilities.

When RETScreen Analysis Program is on, a section where the cover data related to the project will be entered is available on the beginning page. A section where basic data necessary for the analysis will be entered is available under this beginning page. In this section, there are two project types as Method 1 and Method 2. The required data differ according to the Method type chosen. The usage of the program is really easy, and it enables detailed analysis opportunity. Field reference values necessary for "beginning" page and the data integrated on the internet database are automatically loaded onto field data beginning page through data climate bank. The values related to latitude, longitude, altitude, air temperature per month, earth temperature, wind speed, heating, and cooling needs can be livingly seen in RETScreen climate bank.

2.2. Location and Method Selection

To be able to make a detailed analysis, "Method 2" was chosen as analysis method. "Central Network" was selected as network type, and "Lower Heating Value (LHV)" was chosen as thermal reference value. Field Climate Reference values are asked by choosing Tokat from program database.

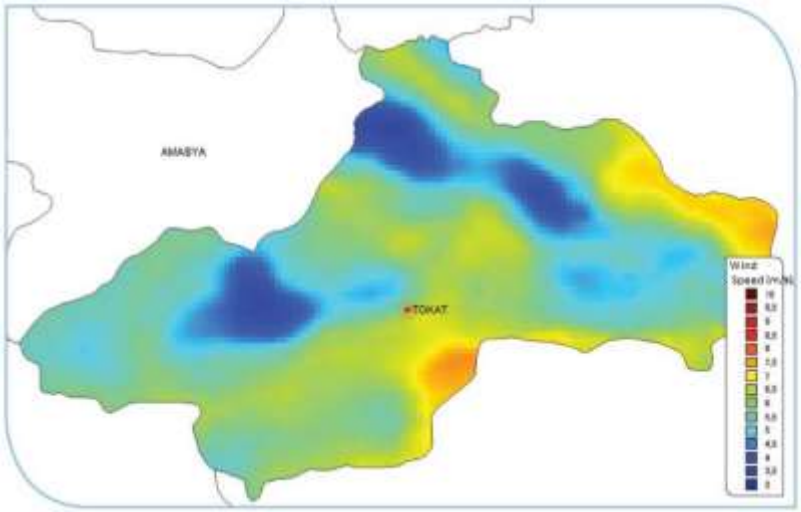

Figure 2. REPA map belonging to Tokat province [8]

The locations where the turbine core height is 7 m/h and faster, and the wind power density is more than 400 W/m^2 should be preferred for the establishment of economical Wind energy system [7, 8]. When we look at REPA map belonging to Tokat province in Figure 2 by benefiting from Wind Energy Potential Atlas prepared by Electric Power Resources Survey and Development Administration, it can be seen that the wind speed is 7.8 m/h at annual average at 24 meter-height.

2.3. The Creation of Energy Model

The maximum annual energy amount from turbines was calculated by choosing wind turbine as energy system technology and selecting wind speed as source evaluation method in energy modelling page. The specific features of this turbine can be seen by choosing one among the different turbines manufactured by various producers in product database integrated in RETScreen 4. Two turbines with 24 m core height and each with 50 kW power were preferred for this study. The chosen turbine features, power, and energy data have been calculated by the program, and they are shown in Table1, Table 2, and Figure 3.

Table 1. Wind turbine features

Wind Turbine		
Power capacity per turbine	kW	50.0
Manufacturer		Endurance Wind Power
Model		E-3120 (3-phase) – 24m
Number of turbines		2
Power capacity	kW	100.0
Hub height	m	24.0
Rotor diameter per turbine	m	19
Swept area per turbine	m^2	290
Energy curve data		Standard
Shape factor		2.0

The rate of transformation of wind power into electricity power by a turbine is called as capacity factor. It is also known as the annual energy amount rate produced by the turbine to the rate of theoretical annual energy amount under nominal power by the turbine [9]. Generally, the capacity factor calculated in RES applications differs from %25 to %35 [10]. The capacity factor determined by the program was calculated as 37.5.

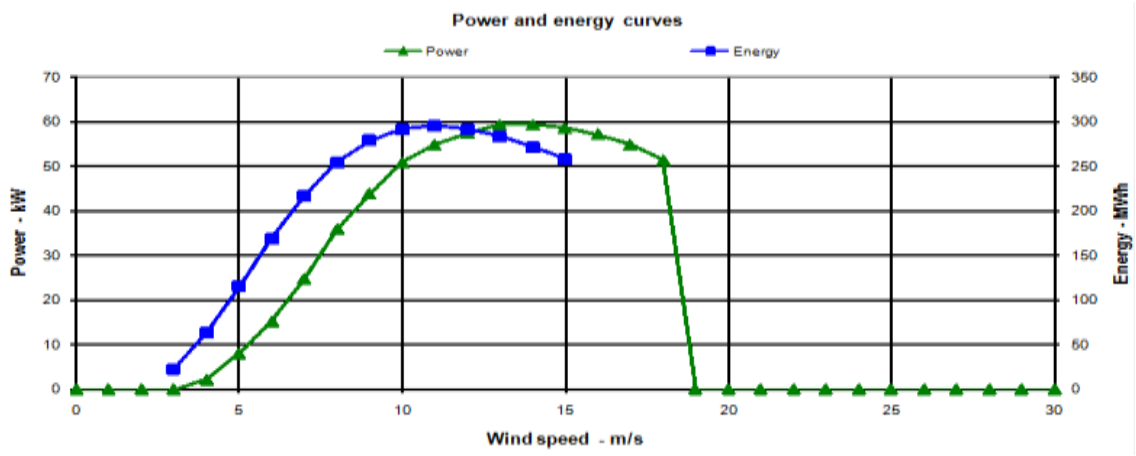

Figure 2. Power and energy curve data of the turbine

Table 2. Power curve and energy curve data of the chosen turbine

Wind speed (m/s)	Power curve data (kW)	Energy curve data(MWh)
0-3	0,0	0,0
4	2,2	63,4
5	8,1	115,7
6	15,2	169,4
7	24,8	217,1
8	35,8	254,0
9	43,8	278,7
10	50,9	291,7
11	54,8	295,2
12	57,3	291,6
13	59,3	283,1
14	59,3	271,7
15	58,6	258,4
16	57,1	-
17	54,9	-
18	51,4	-
19-30	-	-

3. Findings

3.1. Cost Analysis

There are two methods to be able to be chosen in cost analysis section. While the first method enables the costs to be entered under titles for general foresights, the second method enables the different unit's costs under each title to be entered in a more detailed way. In this study, second method was chosen by thinking cost analysis section in a more detailed way. According to the number of used turbines, detailed cost analysis were given in terms of American Dollar and Turkish Liras in Table 3.

Table 3. Detailed cost analysis table

Beginning studies	Study content	Cost calculation	Percentage rate
Feasibility study	Field investigation, source evaluation, environmental evaluation, beginning design, detailed cost calculation, report preparation, project administration and journey expenditures	67.200$-207.49TL	% 5.5
Improvement	Contract meetings, permission and approves, study area soil rate, greenhouse gas records, project financing, regulations accountancy, project management and journey expenditures cost	71.500$-220.71TL	% 5.8
Engineering	Settlement area and construction design, mechanical design, electricity design, tender and construction business, building inspection expenditures	165.600$-511.7TL	% 13.5
Power system	Wind turbine, road construction, transmission line, construction inspection and energy efficiency measures	170.000$-524.76TL	% 13.9
System balance and equipment	Specific project expenditures, Wind turbine establishment cost, wind turbine installation cost and worksite settlement cost, spare parts, transportation, test and cut-in costs	748.222$-2.309.61TL	% 61.2
Annual expenditures	Insurance premium, society benefits, estate tax, specific liabilities	70.350$-217.16TL	-
Periodic expenditures	User expenditures	25.000$-77.17TL	-

3.2. Financial Analysis

The financial analysis section of the program consists of 5 chapters. These are Financial Parameters, Annual Income, Project Costs and Income Summaries, Financial Sustainability, and Annual Cash Flow chapters. In this section, a short data about energy model and cost analysis study pages in “Project Costs and Income Summaries” and “Annual Income” is given. The financial data of the project was obtained by using financial data we entered in “Financial Sustainability” section. In this study, the whole of the investment to be done for this project will be done with stockholder’s equity, and by assuming that the lifetime of the station is 20 years, annual inflation rate for Turkey conditions was accepted as %8; annual income tax rate was thought as %35, and the escalation rate of electricity export price was accepted as %11 [11]. The Cumulative Cash Increase Data were shown in Figure 3.

When the cumulative cash increase data graphic acquired from the system is investigated, it can be seen that there is a system cost with approximately 1.100.000 $ - 3.395.480.00 TL at the beginning. This system starts to gain profit 12 years after its establishment by regaining its cost.

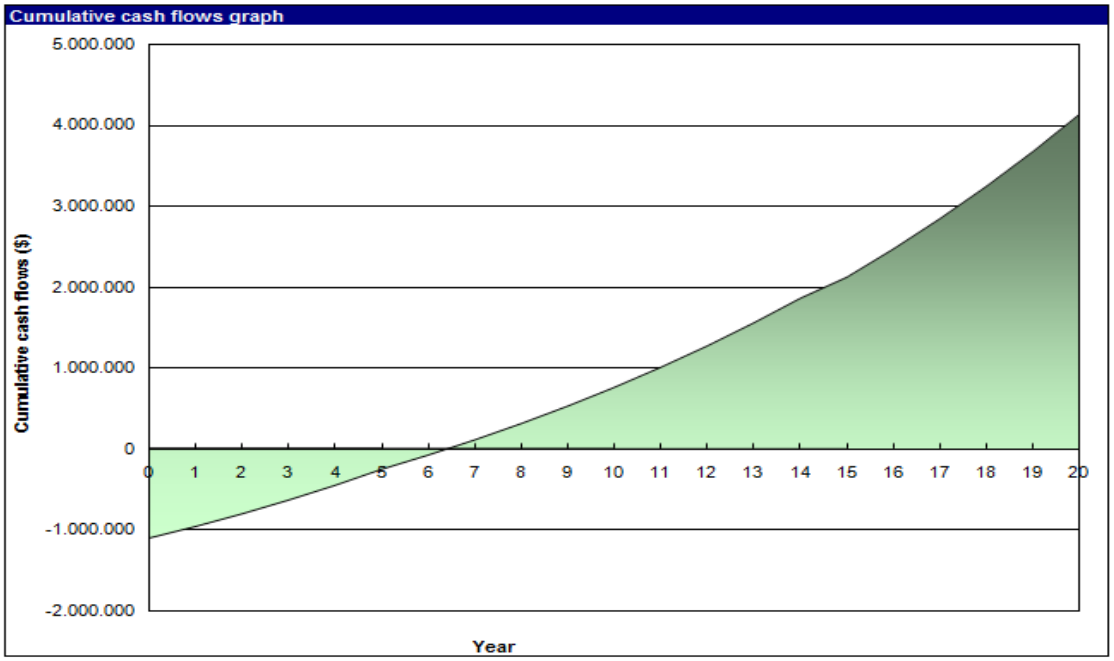

Figure 3. Cumulative Cash Increase Data ($)

4. Result

Evaluation of the capital in this investment is more preferable than the other methods since it is invested into production. The production of clean energy sources includes positive improvements in many areas in its own body. In this study, a cost analysis for the 100 kW system thought to be established on Taşlıçiftlik Campus in Tokat province was done. Wind turbine core height was calculated as 24 m; average annual wind speed, as 7.8 m/h; and the capacity factor, as 37.5. When the acquired data is observed, this system will earn four times of its establishment cost in 20 years, and it will have a %300 profit rate.

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