

Supplying the Energy Demand for a Home With a Wind Turbine in the City Center of Tokat

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Abstract – The wind energy, which causes air movements in the atmosphere and wave movements in the seas, can be transformed into kinetic and mechanical energy. The wind speed varies between 5.5 m/s and 7 m/s on average per year in Tokat province. Although this is not sufficient for a perfect wind energy production center, systems can be developed that can eliminate the average energy requirement of a home. In this study, the selection of the wind turbine that can provide a home need in Tokat province center was made and the system cost to be installed was calculated. When the turbine is selected, the daily energy requirement of the house is calculated. In this direction, the average wind turbine power required to meet the needs of the house has been determined. The power curves of the turbines were also examined to determine the maximum power output. The factors that decrease the efficiency of wind turbines with low yield rate were examined and appropriate turbine design was realized in Tokat provincial center conditions. The energy requirement of a household with an average daily energy requirement of 6 kWh to 7 kWh in the city center with an average output power of 5kW with three blades, a blade diameter of 5.6m, a pole length of 12m, a production start speed of 3 m/s turbine design has been realized. In addition, it has been determined that the cost of the system to be installed in Tokat province varies between 45.000TL and 55.000TL on average depending on the type of material to be used.

Keywords – Wind Turbine, Renewable Energy, Tokat Region.

I. INTRODUCTION

Today, private or legal entities have turned to renewable energy sources. One of the most common types of alternative energy sources is wind energy. The wind energy potential in Turkey is quite high. A lot of work has been done in this regard. In these studies, the potentials of the winds are generally examined and the wind turbines are selected in some areas. Some of these studies are listed below.

İsmail H. Altaş studied the energy sources in Turkey and the potential of these sources[1].

İbrahim Atılğan examined the energy potential of our country and determined its position according to the developed and developing countries[2].

In the study conducted by Mehmet Bilgili and colleagues, the potential of wind energy in the Akhisar, Bababurnu, Belen, Datça, Foça, Gelendost, Gelibolu, Gökçeada and Söke parts of the south, southwest and west coasts of Turkey were analyzed and analyzed statistically[3].

Faruk Köse and Muammer Özgören evaluated the data obtained from the measurements made at the measurement station established at Selçuk University Alaaddin Keykubat Campus region and the potential of wind energy of the region was determined[4].

Uğur Yıldırım and his colleagues examined statistically the potential of wind energy in Niğde[5].

İlker Mert and Cuma Karakuş have examined the potential of wind energy in the Antakya region and have concluded that the turbines to be installed in the region will be efficient in terms of electric energy production[6].

Mehmet Kurban and his colleagues examined the potential of wind energy in the region with the wind measurement pole set at 30 m height on the campus of Anadolu University on 2 September[7].

Vezer Ayhan and his colleagues performed modeling and turbine manufacturing with wind turbine calculations[8].

Engin Çetin and his colleagues have made a situation determination in the electricity energy production plants established in Denizli[9].

Nida Nurbay and Ali Çınar examined the characteristics of the wind turbines on the market and determined their advantages and disadvantages[10].

In his thesis, Ahmet Toprak realized a low power wind energy system and design for electricity generation[11].

In his thesis study, Seyit Ahmet Akdağ examined the use of the Weibull distribution in the potential and economic analysis of wind energy[12].

Cihan Gökçöl and colleagues implemented a system design in matlab program to meet the energy requirement of a house in the Gebze region only by using wind energy without using another energy source[13].

Levent Bilir and Nurdan Yıldırım Özcan worked to determine the annual production of wind turbines in İzmir region[14].

Fatih Yiğit and Ahmet Kabul investigated the economic analysis of meeting the electrical requirements of a house with wind energy in Isparta[15].

II. ENERGY DEMANDS AND TURBINE SELECTION

The mean energy of a house in Tokat province center was calculated (Figure1). The average energy requirement of a house ranges from 6 kWh to 7 kWh per day.

Device	Average Power (watt)	Daily Working Time	Number	Energy Consumption (watt)	Weekly (watt)
Refrigerator	4800	-	1	4800	33600
Lighting	20	5	6	600	4200
Tv-Radio etc.	150	5	-	750	5250
Iron	200	1	1	200	200
Washing Machine	1100	1,5	1	1650	1650
Dishwasher	1100	1,5	1	1650	4950
Computer	100	6	1	600	4200
Other Devices	100	1	1	600	4200
Total					59450

Fig. 1. The weekly energy used in homes

When these requirements are taken into consideration, the system will be switched on during periods when the energy is disconnected in the systems connected to the network, and at the other times, it will be transferred to the main line. These systems will contribute to the country's production as well as the amount of energy that will be reflected to the invoice, which means to get uninterrupted and free energy (Figure 2).

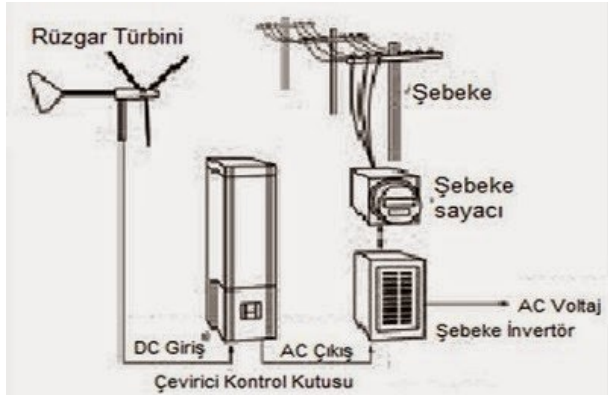


Fig. 2. Network-connected system

For turbine selection to take place, the average wind speed of the zone must first be known. According to Tokat province wind speed data taken from provincial directorate of meteorology in 2010 - 2011, the wind speed was calculated as 6.5 m/s in province center. The average wind speed varies from 7 m/s to 8 m/s. The mean velocity of the zone to be installed is 7 m/s (Figure 3).

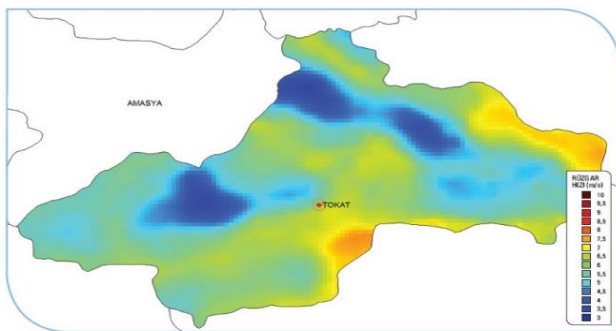


Fig. 3. Tokat region wind speed distribution[16]

When the turbine with the necessary calculated rotor sweep area 24,61m², the rotor diameter 5,6m, the air density 1225 kg/m³, the average efficiency is 59%, the wind power generation at 7m/s wind speed is 3050W and the annual production is 26718 kW, It can be met.

When the average cost of the system is calculated

- Turbine (5 KW): \$ 8000 to \$ 10000
- Direct (12m): \$ 750 to \$ 1000
- Inverter + Protection Box: \$ 2000 to \$ 3000
- Counter (Duplex) + Board: \$ 500 to \$ 750
- Other Expenses (Cable, Connection Equipments, Site Concrete, etc.): \$ 800 to \$ 1000
- The total cost ranges from \$ 12,000 to \$ 15,750. Direk (12m) : 750\$ ile 1000\$

III. CONCLUSION

In this study, it is aimed to supply the energy demand of a house located in the Tokat region with the wind turbine connected to the network. The average installation costs of the selected turbine were also found. It is hoped that the establishment of a house in the Tokat region will shed light on the future of the planned wind turbine system. As a result the energy requirement of a household with an average daily energy requirement of 6 kWh to 7 kWh in the city center with an average output power of 5kW with three blades, a blade diameter of 5.6m, a pole length of 12m, a production start speed of 3 m/s turbine design has been realized. In addition, it has been determined that the cost of the system to be installed in Tokat province varies between 45.000TL and 55.000TL on average depending on the type of material to be used.

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