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1-ICAUD

Making Use Of The Wind Tribunes With The Little Power In The Requirement Of The Electricity Energy Need

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ABSTRACT

In this study it has been aimed that a little amount of the electricity energy need of Celal Bayar Universty Golmarmara Vocational high school in the city Manisa will be covered by the wind tribunes with the little power.
In this study, the electricity energy amounts, which will be produced by the wind tribunes of 2kW, 3kW and 5kW has been kept as aim. To be able to determine the energy amounts from these tribunes, the wind speed and direction data of 8260 hours for 1 year has been provided from the meteorology station. These data of 8760 hours for a year has been registered making use of Excel computer program. The quivalent of these wind speeds of 8760 hours measured at 10 metres height coinciding at the altitude of 20m and 30m have also been accounted at excell computer program using Hellman‘s Relation. The theoretical power, net power and electricity energy values of each hour to be produced from the 2kW, 3kW and 5kW' wind tribunes for the altitudes of 10m, 20m and 30 metres have been accounted one by one.
At the end of the study, it has been concluded that the basic needs such as the enlightening and computer of the Vocational high school can easily be obtained from a wind tribune with little power.

1 INTRODUCTION

Due to the fossil resources decreasing day by day and the environmental problems increasing , renewable energy resources are met with an increasing interest all over the world and seen as significant sources in meeting the need for energy. The wind energy whose usage and technology develop most quickly among these renewable energy resources comes on top of all (Kose and Ozgur, 2004). When that wind energy is both local source and clean and nature-friendly is taken into consideration, that it has an important part in solving the problems of our day can be seen (Kose, 2004). When all these factors are taken into account, trying to compensate the needs with renewable energy resources will both reduce the environmental pollution and increase the life span of reserves by limiting the usage amount of fossil resources which have been decreasing every other day. Consequently, research on these matters should continually be strengthened and supported (Aydin, 2008).

In this study, it has been aimed to meet a portion of electric energy need of Golmarmara Vocational College situated in the center of Manisa with a self-contained (autonomous) system. Autonomous system energy produced by the wind tribunes is consumed by the load linked to the system. In addition, if the produced energy is higher than the requirement of the load, the extra produced energy is stored in an accumulator storage as an electrochemical (electricity energy). If the energy requirement of the load is higher than the produced energy, the lacking energy is met from this very storage.

2 MATERIALS AND METHODS

In this study it has been aimed that a little amount of the electricity energy need of Golmarmara Vocational high school in the city Manisa will be covered by the wind tribunes with the little power.
In this study, the electricity energy amounts, which will be produced by the wind tribunes of 2kW, 3kW and 5kW has been kept as aim. To be able to determine the energy amounts from these tribunes,

the wind speed and direction data of 8260 hours for 1 year has been provided from the meteorology station. These data of 8760 hours for a year has been registered making use of Excel computer program. The quivalent of these wind speeds of 8760 hours measured at 10 metres height coinciding at the altitude of 20m and 30m have also been accounted at excell computer program using Hellman's Relation. The theoretical power, net power and electricity energy values of each hour to be produced from the 2kW, 3kW and 5kW' wind tribunes for the altitudes of 10m, 20m and 30 metres have been accounted one by one.

2.1 Turbine Choice

In the study conducted to meet the need of electricity energy from the wind turbines, 3 wind turbines with Powers of 2 kW, 3 kW and 5 kW have been chosen and scrutinized. The turbines used in the circulation are given in Table 1 with their technical and economic characteristics.

	FD3.6-2000-10 (2000W)	**FD6.4-3000-16 (3000W)**	**FD6.4-5000-16 (5000W)**
Model	HS2K	HS3K	HS5K
Rotor Diameter(m)	3.2	4.7	6.4
Power(W)	2000	3000	5000
Maximum power(W)	2500	4000	6000
DC output (V)	120/220	240	240
Used Inverter AC output (V/Hz)	110/60 220/50	110/60 220/50	220/50 380/60
Accumulator used in storage(V/AH)	12 / 100*20	12 / 200*20	12 / 300*20
Total cost (USD$)	**2,753**	**5,449**	**8,104**

Table 1: The technical and economic characteristics of the wind turbines (Aydin, 2008).

2.2 Evaluation Of Wind Measurements

The wind speed shows a specific change depending on the height above the ground. By using the wind speed at a known specific height, the wind speed at any height can be reached. In this study, by using the Hellman's relation, the wind measuring data obtained at 10 meters height with their wind speeds at 20 meters and 30 meters have been calculated. This relation is;

$$V_{rist}/V_{röl\c{c}} = (H_{ist}/H_{öl\c{c}})^{\alpha} \quad (1)$$

Here;
$V_{r(ist)}$: Wind speed at demanded height (m/s)
$V_{r(öl\c{c})}$: Wind speed at calculated height (m/s)
H_{ist} : Demanded height (m)
$H_{öl\c{c}}$: Calculated height (m)

Rate α in relation number (1) has been chosen 0,18 from Table 2 for green and effective area.

Situation	**α**
Coastline	0,1 – 0,13
Green & Effective Area	0,13 – 0,2
Forested Area	0,2 – 0,27
High-built and Urban Area	0,27 – 0,4

Table 2: The Effect Of Surface Roughness On Wind Velocity (Sen, 2003).

In the light of the calculations, the wind speeds at 20m and 30m heights of an area whose measuring at 10m height was made have been found. Later on, depending on these reports, the theoretic and absolute power which will be obtained from the 2 kW, 3 kW, 5 kW turbines at heights of 10m, 20m, 30m has been calculated.

Using the following formula;

$$P_r=1/2\ \rho\ A\ V^3 \qquad (2)$$

calculations have been made in Excel for 8760 wind speed data at the heights of 10m, 20m, 30m and for the wind turbines with the powers of 2 kW, 3 kW, 5 kW.

In this formula;
P : Power Factor (W)
ρ : Density of Air (kg/m^3)
A: Swept Area (m^2)
V: (m/s) Expresses the Wind Speed

While calculating the power of turbines, firstly the maximum power which will be obtained from the turbine is calculated with number (3) equation. This maximum power was founded by BETZ in 1962. According to this theory, the maximum power taken from the turbine is determined as almost 0,59. This is defined as theoretic power.

$$P_{r(max)}=0{,}59*1/2\ \rho\ A\ V^3 \qquad (3)$$

By using number (3) equation, the maximum power taken from the turbine has been calculated in Excel for 8760 wind speed data at the heights of 10m, 20m, 30m and for the wind turbines with the Powers of 2 kW, 3 kW, 5 kW.

While determining the absolute power obtained from the turbines, how much power the turbines produce with how much speed is divided with the maximum power which is obtained from the turbines at those speeds, which has been found with the capacity factor (Cp).By using this real Cp factor, the real power obtained from the turbines has been calculated with the number (4) relation. By using this capacity factor, 0,47 for turbine 2 kW, 0,40 for turbine 3 kW and 0,36 for turbine 5 kW have been reached. Using the real Cp relation calculated for each turbine in relation (4) and by placing 8760 hourly measurements at heights of 10m, 20m, 30m in the equation, mathematical operations have been made in Excel.

$$P_{r(gerçek)}=Cp_{(gerçek)}*1/2\ \rho\ A\ V^3 \qquad (4)$$

How much energy the turbines produce with these hourly wind powers have been reached with relation number (5). Sine power values are calculated hourly and the produced energy is multiplied with 1, the power and energy values are equal to one another.

Energy = Power * Time

$$E = P * t \qquad (5)$$

In the light of the turbines with powers of 2 kW, 3 kW and 5 kW chosen after all the measurements carried out, it is given in Table 3-11 how much of the need they can compensate in the region of Manisa where measurements are carried out. For these turbines at heights of 10m, 20m and 30m, theoretic power, absolute power and the energy values obtained hourly have been calculated seperately for 12 months.

3 RESULTS

In this study specificly carried out for Manisa, having obtained data of wind measurements at 10m height from Manisa Region Directorship of Meteorology, based upon these data, we have measured the wind speed at heights of 20m, 30m with Hellman's relation. Laten on, based on these data, the wind powers at 10m, 20m and 30m heights and theoretic power, real power and hourly electric energy values obtained from 2 KW, 3 kW and 5 kW turbines for 10m, 20m and 30m heights have seperately been calculated and are displayed in Table 3-11.

Months		Jan.	Fab.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Density (kg/m^3)		1,255	1,255	1,255	1,255	1,255	1,255	1,255	1,255	1,255	1,255	1,255	1,255	
Type of Turbine	Rotor Diameter (m)	3,2	3,2	3,2	3,2	3,2	3,2	3,2	3,2	3,2	3,2	3,2	3,2	
2 kW	Theoretic Efficiency	0,59	0,59	0,59	0,59	0,59	0,59	0,59	0,59	0,59	0,59	0,59	0,59	
	Real Efficiency	0,47	0,47	0,47	0,47	0,47	0,47	0,47	0,47	0,47	0,47	0,47	0,47	
	Theoretic Power (kW)	280,35	210,76	178,90	88,48	157,62	225,06	290,92	251,15	120,98	171,48	63,40	233,94	2273,04
	Absolute Power (kW)	223,33	167,89	142,52	70,49	125,56	179,29	231,75	200,07	96,38	136,60	50,51	186,36	1810,72
	Obtained Energy (kWh)	223,33	167,89	142,52	70,49	125,56	179,29	231,75	200,07	96,38	136,60	50,51	186,36	1810,72

Table 3: The values obtained from 2 kW turbine at 10m height.

Months		Jan.	Fab.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Density (kg/m^3)		1,255	1,255	1,255	1,255	1,255	1,255	1,255	1,255	1,255	1,255	1,255	1,255	
Type of Turbine	Rotor Diameter (m)	3,2	3,2	3,2	3,2	3,2	3,2	3,2	3,2	3,2	3,2	3,2	3,2	
2 kW	Theoretic Efficiency	0,59	0,59	0,59	0,59	0,59	0,59	0,59	0,59	0,59	0,59	0,59	0,59	
	Real Efficiency	0,47	0,47	0,47	0,47	0,47	0,47	0,47	0,47	0,47	0,47	0,47	0,47	
	Theoretic Power (kW)	407,62	306,44	260,12	128,65	229,17	327,23	422,99	365,16	175,91	249,32	92,18	340,14	3304,93
	Absolute Power (kW)	324,71	244,11	207,22	102,48	182,56	260,68	336,95	290,89	140,13	198,61	73,43	270,96	2632,74
	Obtained Energy (kWh)	324,71	244,11	207,22	102,48	182,56	260,68	336,95	290,89	140,13	198,61	73,43	270,96	2632,74

Table 4 : The values obtained from 2 kW turbine at 20m height.

Months		Jan.	Fab.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Density (kg/m^3)		1,255	1,255	1,255	1,255	1,255	1,255	1,255	1,255	1,255	1,255	1,255	1,255	
Type of Turbine	Rotor Diameter (m)	3,2	3,2	3,2	3,2	3,2	3,2	3,2	3,2	3,2	3,2	3,2	3,2	
2 kW	Theoretic Efficiency	0,59	0,59	0,59	0,59	0,59	0,59	0,59	0,59	0,59	0,59	0,59	0,59	
	Real Efficiency	0,47	0,47	0,47	0,47	0,47	0,47	0,47	0,47	0,47	0,47	0,47	0,47	
	Theoretic Power (kW)	507,39	381,45	323,79	160,14	285,27	407,33	526,52	454,54	218,96	310,35	114,75	423,40	4113,88
	Absolute Power (kW)	404,19	303,87	257,94	127,57	227,25	324,48	419,43	362,09	174,43	247,23	91,41	337,28	3277,16
	Obtained Energy (kWh)	404,19	303,87	257,94	127,57	227,25	324,48	419,43	362,09	174,43	247,23	91,41	337,28	3277,16

Table 5: The values obtained from 2 kW turbine at 30m height.

Months		Jan.	Fab.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Density (kg/m^3)		1,255	1,255	1,255	1,255	1,255	1,255	1,255	1,255	1,255	1,255	1,255	1,255	
Type of Turbine	Rotor Diameter (m)	4,7	4,7	4,7	4,7	4,7	4,7	4,7	4,7	4,7	4,7	4,7	4,7	
3k kW	Theoretic Efficiency	0,59	0,59	0,59	0,59	0,59	0,59	0,59	0,59	0,59	0,59	0,59	0,59	
	Real Efficiency	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4	
	Theoretic Power (kW)	604,77	454,66	385,94	190,88	340,02	485,51	627,57	541,78	260,99	369,92	136,77	504,66	4903,46
	Absolute Power (kW)	410,02	308,24	261,65	129,41	230,52	329,16	425,47	367,31	176,94	250,79	92,73	342,14	3324,38
	Obtained Energy (kWh)	410,02	308,24	261,65	129,41	230,52	329,16	425,47	367,31	176,94	250,79	92,73	342,14	3324,38

Table 6: The values obtained from 3 kW turbine at 10m height.

Months		Jan.	Fab.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Density (kg/m^3)		1,255	1,255	1,255	1,255	1,255	1,255	1,255	1,255	1,255	1,255	1,255	1,255	
Type of Turbine	Rotor Diameter (m)	4,7	4,7	4,7	4,7	4,7	4,7	4,7	4,7	4,7	4,7	4,7	4,7	
3 kW	Theoretic Efficiency	0,59	0,59	0,59	0,59	0,59	0,59	0,59	0,59	0,59	0,59	0,59	0,59	
	Real Efficiency	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4	
	Theoretic Power (kW)	879,32	661,06	561,14	277,53	494,38	705,91	912,47	787,73	379,47	537,85	198,86	733,76	7129,49
	Absolute Power (kW)	596,15	448,18	380,44	188,15	335,17	478,58	618,63	534,06	257,27	364,64	134,82	497,46	4833,55
	Obtained Energy (kWh)	596,15	448,18	380,44	188,15	335,17	478,58	618,63	534,06	257,27	364,64	134,82	497,46	4833,55

Table 7: The values obtained from 3 kW turbine at 20m height.

Months		Jan.	Fab.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Density (kg/m^3)		1,255	1,255	1,255	1,255	1,255	1,255	1,255	1,255	1,255	1,255	1,255	1,255	
Type of Turbine	Rotor Diameter (m)	4,7	4,7	4,7	4,7	4,7	4,7	4,7	4,7	4,7	4,7	4,7	4,7	
3 kW	Theoretic Efficiency	0,59	0,59	0,59	0,59	0,59	0,59	0,59	0,59	0,59	0,59	0,59	0,59	
	Real Efficiency	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4	
	Theoretic Power (kW)	822,87	822,87	698,49	345,46	615,39	878,70	1135,82	980,55	472,35	669,50	247,54	913,36	8602,89
	Absolute Power (kW)	557,88	557,88	473,56	234,21	417,21	595,73	770,05	664,78	320,24	453,90	167,82	619,23	5832,47
	Obtained Energy (kWh)	557,88	557,88	473,56	234,21	417,21	595,73	770,05	664,78	320,24	453,90	167,82	619,23	5832,47

Table 8: The values obtained from 3 kW turbine at 30m height.

Months		Jan.	Fab.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Density (kg/m^3)		1,255	1,255	1,255	1,255	1,255	1,255	1,255	1,255	1,255	1,255	1,255	1,255	
Type of Turbine	Rotor Diameter (m)	6,4	6,4	6,4	6,4	6,4	6,4	6,4	6,4	6,4	6,4	6,4	6,4	
5 kW	Theoretic Efficiency	0,59	0,59	0,59	0,59	0,59	0,59	0,59	0,59	0,59	0,59	0,59	0,59	
	Real Efficiency	0,36	0,36	0,36	0,36	0,36	0,36	0,36	0,36	0,36	0,36	0,36	0,36	
	Theoretic Power (kW)	1121,39	843,04	715,62	353,93	630,48	900,24	1163,67	1004,58	483,93	685,91	253,60	935,75	9092,15
	Absolute Power (kW)	684,24	514,40	436,65	215,96	384,70	549,30	710,03	612,97	295,28	418,52	154,74	570,97	5547,75
	Obtained Energy (kWh)	684,24	514,40	436,65	215,96	384,70	549,30	710,03	612,97	295,28	418,52	154,74	570,97	5547,75

Table 9: The values obtained from 5 kW turbine at 10m height.

Months		Jan.	Fab.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Density (kg/m^3)		1,255	1,255	1,255	1,255	1,255	1,255	1,255	1,255	1,255	1,255	1,255	1,255	
Type of Turbine	Rotor Diameter (m)	6,4	6,4	6,4	6,4	6,4	6,4	6,4	6,4	6,4	6,4	6,4	6,4	
5 kW	Theoretic Efficiency	0,59	0,59	0,59	0,59	0,59	0,59	0,59	0,59	0,59	0,59	0,59	0,59	
	Real Efficiency	0,36	0,36	0,36	0,36	0,36	0,36	0,36	0,36	0,36	0,36	0,36	0,36	
	Theoretic Power (kW)	1630,4	1225,7	1040,4	514,60	916,69	1308,93	1691,94	1460,64	703,62	997,30	368,73	1360,56	13219,73
	Absolute Power (kW)	994,86	747,92	634,88	313,99	559,34	798,67	1032,37	891,24	429,33	608,52	224,99	830,17	8066,28
	Obtained Energy (kWh)	994,86	747,92	634,88	313,99	559,34	798,67	1032,37	891,24	429,33	608,52	224,99	830,17	8066,28

Table 10: The values obtained from 5 kW turbine at 20m height.

Months		Jan.	Fab.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Density (kg/m^3)		1,255	1,255	1,255	1,255	1,255	1,255	1,255	1,255	1,255	1,255	1,255	1,255	
Type of Turbine	Rotor Diameter (m)	6,4	6,4	6,4	6,4	6,4	6,4	6,4	6,4	6,4	6,4	6,4	6,4	
5 kW	Theoretic Efficiency	0,59	0,59	0,59	0,59	0,59	0,59	0,59	0,59	0,59	0,59	0,59	0,59	
	Real Efficiency	0,36	0,36	0,36	0,36	0,36	0,36	0,36	0,36	0,36	0,36	0,36	0,36	
	Theoretic Power (kW)	2029,5	1525,7	1295,1	640,56	1141,07	1629,31	2106,08	1818,16	875,85	1241,41	458,99	1693,59	16455,53
	Absolute Power (kW)	1238,3	930,99	790,27	390,85	696,25	994,16	1285,06	1109,39	534,42	757,47	280,06	1033,37	10040,66
	Obtained Energy (kWh)	1238,3	930,99	790,27	390,85	696,25	994,16	1285,06	1109,39	534,42	757,47	280,06	1033,37	10040,66

Table 11: The values obtained from 5 kW turbine at 30m height.

At the end of the study, it has been concluded that the basic needs such as the enlightening and computer of the Vocational high school can easily be obtained from a wind tribune with little power.

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