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ALTERNATIVE ENERGY SYSTEM DESIGN FOR AGRICALTURAL IRRIGATION

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Abstract
The unit cost of electricity production with alternative energy system began to fall together with developments in technology. Reduction of costs, diminishing reserves of fossil fuels have increased the interest in alternative energy systems. Alternative energy systems are used in almost every industry. In this study, designing a hybrid system with wind and solar energy are calculated to operate the pump to be used for irrigation.

Keywords: Wind Energy, Solar Energy, Agricaltural Irrigation

INTRODUCTION

Solar Energy

Solar Energy is an energy type that emerges from the process of transformation of hydrogen gas from the sun to helium. Various energy waves from the sun disseminate which is a thermonuclear reactor and all the energy that has been dispersed, only 1 out of 2 billion reaches the Earth surface. Since the sun is going to keep on luminescing for millions and millions of years, it is a never ending energy source for our world.

The Advantages of Solar Energy

- Solar energy is a no consumable energy resource.
- Solar energy hasn't got any harmful substances such as; gas, smoke, dust, carbon, sulphur.
- Solar energy eradicates the dependence between countries.
- You can provide everywhere without any transportation payment.
- You don't need any complex technology in order to use it.

The Disadvantages of Solar Energy

- Solar energy may not be found everywhere and at every density when you desire.
- The energy that is coming from the sun cannot be controlled when we desire.
- It requires stocking up when it is highly demanded.
- Currently, cost of first investment for use of energy mechanism is very high.
- In winter when energy is needed so much, there is poor amount of sun ray and even there is none at night.

Wind Energy

Since the world's heating up and cooling is unequal, wind generates from the affection of forces. Wind energy is generated from of the air stream mobilization energy.

The Advantages of wind energy

- Wind energy is a clear, harmless energy to the environment, does not have any oil expense
- Wind energy has no transmission costs.
- The wind at nature can be used directly.
- It's a renewable energy resource. It has no foreign dependency. It can be produced only with local capabilities.
- Wind turbines aren't complex machines. There are used very simply without needing an operator.
- It does not cause explosions and it does not disseminate radiation.

Disadvantages of wind energy

- Since the energy production is depended on wind, windbreaks and wind reduction could cause energy losses.

- Wind turbines can only be installed in areas where there is sufficient wind.
- First investment costs for türbine can be very high.
- Rotating machines are so big that it could cause birds to die in the area.
- Loudness of voice of the wind turbines may reflect to the surrounding.

Solar-Wind Hybrid Energy Producing Systems' Aparts

Solar-Wind Hybrid Energy Producing Systems' Aparts diagram is shown in figure-1.

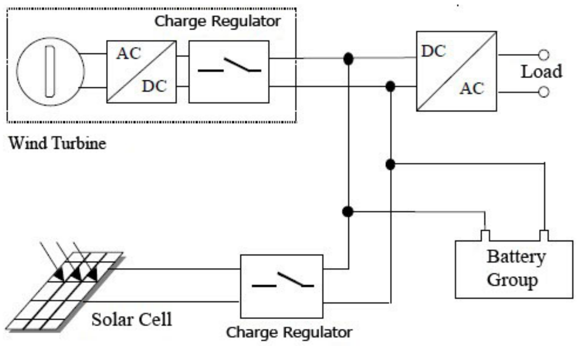


Fig 1. *Solar wind hybrid power generation system*

Wind turbine

Wind turbine transforms mobilizing airs' kinetic energy to mechanic and electric energy. The amount that is acquired depends on winds speed. The installation site should be where wind speed is very high and air stream is not obstructed.

Solar Battery

Photovoltaic cells transform solar light to the right stream and production keeps on going if there is enough light. Solar Battery cells are made out of semi conductive equipment's. Silicon is the most preferred semi conductive equipment. First investment costs are very high.

Battery

Batteries are electro-chemical parts that stocks up the energy in chemical forms. All the energy that is obtained from the turbines and PV panels are stocked up here. Expected life of an item is 5-10 years.

Charge Regulators

Charge regulators are used in hybrid systems in which to monitor the working of the system.

Load

In the system, 0.75 kw power DC pump is used.

Design and Calculator

The measurement of plant house that is going to be used in the application is: 25x 40m and calculated as 1000 m^2. The plant house that is going to be calculated is in Tekirdağ/ Süleymanpaşa. The geographical location of the plant house which is calculated is at a sea level and it is a bowless land. Hence, application pressures are taken as 1 bar.

The Definition of the Pipes which will be used in the System

The system has 3 main line pipes and 13 drip irrigation pipes.

1) The main line pipe which is responsible about the carriage from the well to the pump (L_{ah1}): 9 meters
2) The feeding pipe which is responsible about the carriage from the pump to the main line pipe which feeds drip irrigation pipes (L_{ah2}): 7 meters
3) The main pipe line which feeds the drip irrigation pipe lines (L_{ah3}): 24 meters

   If it's required to define the drip irrigation pipes;

   The lengths of these pipes' are 37 meters. (L_{db}= 37m)

   The market standarts are considered drippers which have 2L/h flow and 20 cm gap between each are chosen.

Finding the Flow of the System

$$Q_{Group} = \frac{\text{Pipe Length} * \text{Dripper Flow}}{\textit{Dripper Range}}$$

$$Q_{Group} = 1{,}02 * 10^{-4} \text{ m}^3/\text{sn}$$

The system has 13 drip irrigation pipes. The flow of the main line pipe, total flow, is equal to the flows of the 13 drip irrigation pipes.

Q_{total}= 13,36*10^{-4} m^3/s

The speed of the water in the drip irrigation pipe

$Q_{Group}=V_{Group}*A_{db}$

V_{Group}=0,51 m/s

The velocity of the main line pipe is chosen 2 m/s as it fits with industrial functions.

Determining the Diameter of the Main Line Pipe

When we examine the flow & pipe diameter & velocity chart for water, the flow which is on the intersection of diameter and velocity values gives us the maximum flow in the mentioned parameters. When we consider the main line velocity as 2 m/s and the main line flow as 4.8 m^3/h, the maximum flow is 5.79 m^3/h. This value is equal to DN 32 standarts.

These followings are the DN 32 standarts:

-Outer diameter 42.4 mm
-Wall thickness 3.6 mm
-Inner diameter 35.2 mm

We take the inner circle into account in pipe calculations. So the diameter of the main line pipe is 35.2 mm. (d_{ah}= 35.2 mm)

Determining the Flowing Types in the Pipes

Flowing type in the main line pipes;

$$Re$$

Re= 69702 > 2300

The flow in the main line pipes is turbulent. The pipe is made out of plastic. We take moody diagram into account and it's calculated as f.

E= 0.0025 and f_{ah}= 0.0050 in plastic pipe.

$$Re$$

Re = 6229 > 2300

The flow in the drip irrigation pipes is turbulent. The pipe is made out of plastic. We take moody diagram into account and it's calculated as f.

E= 0.0025 and f_{ah}= 0.0050 in plastic pipe.

All the local losses are calculated as;

$H_{local}=h_{suddencontraction}+h_{branchflow}+h_{elbow}$

H_{local} =0,71 mSS

Determining the Pump Head

Bernoulli Equation is needed to determine the pump power. 2 spots are needed for the equation. If we consider the well as the first point and the exits of the dripping pipes as the second spot and apply the Bernoulli Equation;

The water in the well doesn't have a velocity. V_1= 0

The well is in contact with the air. P_1= 0

The water is in contact with the air in the exit. P_2= 0

Z_1=0 Z_2=9 m

d_{db}=0.016 m

d_{ah}=0.0354 m

V_{ah}=2 m/s V_2=2 m/s

H_{pump}= 13,05 mSS

$P_{mechanical}= H_{pump} * \gamma_{water} * Q_{system}$

$P_{mechanical}$ = 170 W

The flow is 4.8 m^3/h and the pressing height is 12.05 mSS. If we match the values, we can see the most proper pump type is the submersible pump 4SD608 serial.

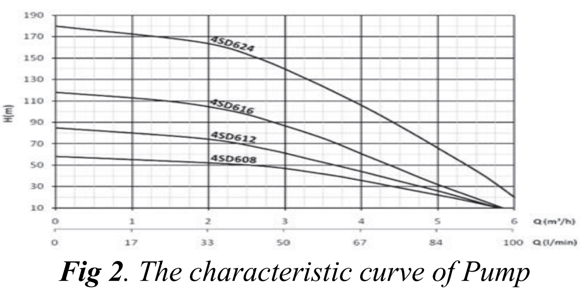


***Fig 2**. The characteristic curve of Pump*

The characteristic curve graphic and efficiency graphic are intersected and the efficiency of the pump (n_{pump}) is determined 0.22.

The power of the pump type which will be used must be higher than the required pump flow in the system.

Electrical power of the pump

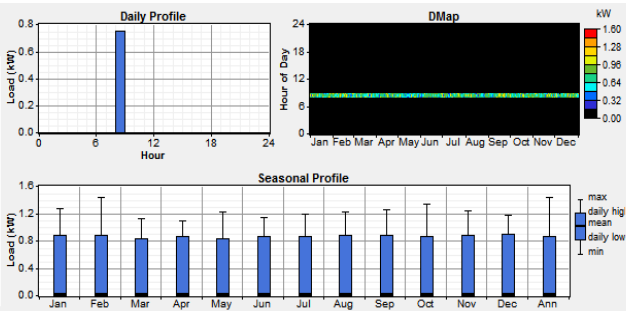
$P_{electirical}=P_{mechanical}/\eta_{pump}=170/0.22=680$ Watt

The most proper pump type is the submersible pump with 0.75 Kilowatt power.

Simulation Program

The chosen DC pump is calculated as 0.75 KW and entered into program. The peak burden is calculated as 1.2 kW by the program.

The working hour of the system is referenced as 1 hour and the working hour is between 08:00 and 09:00.



	Baseline	Scaled
Average (kWh/d)	0.750	0.750
Average (kW)	0.0312	0.0313
Peak (kW)	1.44	1.19
Load factor	0.0262	0.0262

Fig 3. Simulation Program Results

PV panel which has 220W of power and Wind Turbine which has 400W of power are used in the system.

The graphic of Wind Turbine's Power Produce;

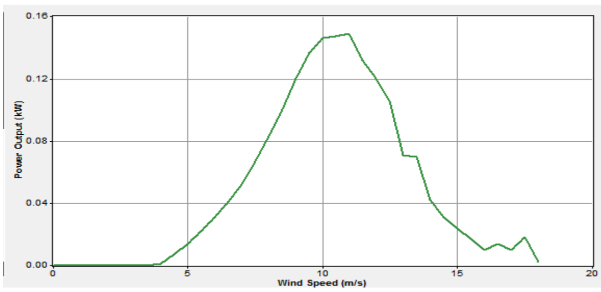


***Fig 4.** Wind Turbine Efficiency Graphic*

The wind turbine's;

Rotor diameter: 1.15m

Power: 400W

Tower height: 8.2m

The features and the capacity graphic of battery is given below.

Nominal capacity:	200 Ah
Nominal voltage:	12 V
Round trip efficiency:	80 %
Min. state of charge:	40 %
Float life:	10 yrs
Lifetime throughput:	917 kWh
Suggested value:	900 kWh
Max. charge rate:	1 A/Ah
Max. charge current:	60 A

Capacity curve

Current (A)	Capacity (Ah)
414.00	34.50
339.00	56.50
275.00	68.75
177.00	88.50
121.00	121.00
47.30	141.90
34.90	174.50
18.70	187.00
10.00	200.00

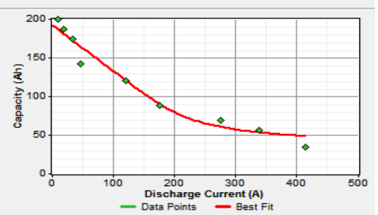


***Fig 5.** Battery Specification*

Month	Clearness Index	Daily Radiation (kWh/m2/d)
January	0.614	2.500
February	0.568	3.110
March	0.538	4.030
April	0.504	4.810
May	0.565	6.220
June	0.645	7.480
July	0.700	7.890
August	0.726	7.310
September	0.749	6.130
October	0.658	3.990
November	0.628	2.750
December	0.568	2.070

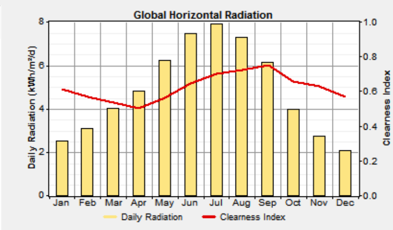


***Fig 6.** Global Radiation for Tekirdağ*

The chosen city Tekirdağ for installing the system and its radiation level in the last 22 years according to distribution of months;

The Average Wing Speed Level in Tekirdağ shown in fig 7.

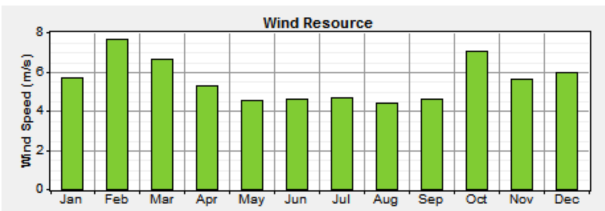
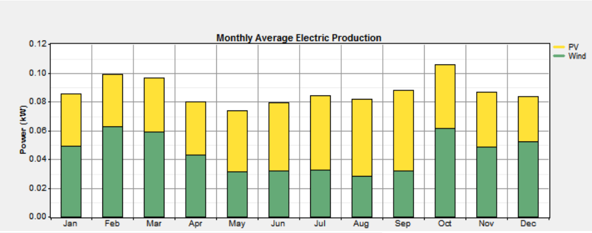


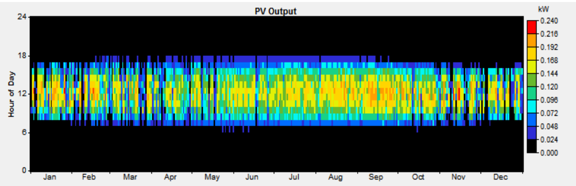
***Fig 7.** Wind Speed for Tekirdağ*

The Results that was obtained after it was simulated via simulation program;



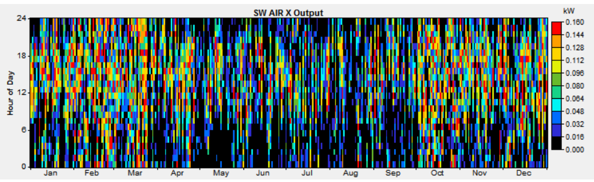
Production	kWh/yr	%
PV array	374	49
Wind turbine	389	51
Total	763	100

Fig 8. Productions of PV panels and wind turbines according to the months:



Quantity	Value	Units
Rated capacity	0.220	kW
Mean output	0.04	kW
Mean output	1.02	kWh/d
Capacity factor	19.4	%
Total production	374	kWh/yr

Fig 9. Production capacity of PV panels according to hours and months



Quantity	Value	Units
Total rated capacity	0.400	kW
Mean output	0.04	kW
Capacity factor	11.1	%
Total production	389	kWh/yr

Fig 10. The Distribution of Wind turbines' production capacity according to hours and months

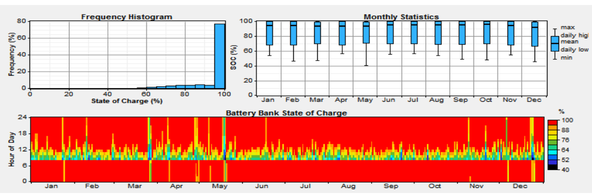


Fig 11. Distribution of the Battery according to hours and months

CONCLUSION

In this study, a theoretical system design was carried out to realize the irrigation of 1000 m2 agricultural land. A 0.75 kW submersible pump pump was used to meet irrigation needs. Total irrigation for irrigation 13,36 m3 / s water from the main pipe, 13 separate branches are irrigation is done. Irrigation is applied as one hour a day. The electricity requirement of irrigation pump is 49% solar energy and 51% wind energy. The electricity needed is stored in the battery and transferred to the system. The applied system derives all the electricity needs from alternating energies. The power and efficiency analyzes of the designed system are calculated by computer aided program.

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