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DESIGN A HYBRID SYSTEM FOR A REMOTE AREA BY USING RENEWABLE RESOURCES IN BANGLADESH

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ABSTRACT**:** *The present demand of energy is increasing day by day due to various reasons such as increasing population, the aspiration for improved living standards and general economic and industrial growth. In the wake of the increasing world energy crisis which mostly affected least development countries, the alternative energy resource has been increased considerably. In this regard, wind and solar as a source of energy can hold good prospect for an underdeveloped country like Bangladesh. Besides, utilization of wind and solar energy has been growing rapidly in the whole world due to the environmental pollution, consumption of the limited fossil fuels and global warming. Bangladesh has fairly wind and sun's energy potential. The purpose of this study is is to investigate the entry of renewable energy technologies into remote areas electricity markets, with particular focus on a new technology. In the current study, wind and solar characteristic and their potentials in the coastal area are investigated where .wind and solar radiation data were processed as hourly and monthly basis. It is seen that, used of a renewable energy resource is very preferable for remote area Therefore hybrid system can be a good system for the remote area like Kuakata.*

Keywords: Homer software, Wind Turbine, solar panel, Monthly variation of wind speed Diagram, Battery with controller.

1. INTRODUCTION

Bangladesh is a small country but its population is very large so power demand is very high. Most of villages of our country even not have power supply. At present only 49 percent of the population in Bangladesh has access to electricity. The rural areas of Bangladesh, where 76% of the population live,in are seriously deprived of electricity. Average demand of our country is 6500MW, but in the time of irrigation & in hot summer season the peak demand is even more than 7000MW. Government hardly generates 4000-5000MW [9], which is insufficient to meet our demand. As a result load shading is a common scenario in our country. Most of villages & Island of our country even not have power supply. The amount of nonrenewable energy resources of Bangladesh is very limited. The country is facing acute energy crisis & serious desertification problem in rural areas. Beside there is no any nonrenewable resources any Island. This problem can be solved by using renewable energy. Suppose for Kuakata[5] which location is Kalapara near bus stand, Kuakata Sadar, Kuakata, Patuakhali,21°54.76' North Latitude 90°08.24' East Longitude & Height of Station 30m.This sea-beach there is no any nonrenewable resources but renewable resources is available. For example solar energy, wind energy, wave energy etc. Beside Kuakata is a tourism place so here power is very necessary for some hotel & restaurant. So we have decided to put a power plant which resources will be renewable energy. Its population approximately 5200, number of family is 500. Main occupation of this people is fishing, so most of the people are live in under scale of poorer. So every family could not ability to connect the power. Probably 200 families can ability to connect the power. So here average power demand is 180 kWh/day and peak demand is 15 kW.Now for 200 families power demand is approximately 175 KWh/day. To overcome this vital problem of remote area we have to use the hybrid power system. Therefore this paper presents the idea to use renewable hybrid energy in remote area.

2. HYBRID POWER SYSTEM

Hybrid power systems (HPS) are any autonomous electricity generating systems combining renewable energy sources and conventional generators.pv-Wind-diesel systems, which combine of solar panel, wind turbines and diesel generators are a subclass of

HPS. The purpose of these systems is to produce as much energy as possible from the renewable sources while maintaining an acceptable power quality and reliable supply. Furthermore, the fuel savings and lower generation costs obtained with the HPS should at least balance the high investment costs for renewable energy generators, controllers, dump loads, storage units, converters,etc . The main parts of the system are the: (a) Wind Energy Conversion system (WEC); (b) Photovoltaic system (PV); (c) Diesel Generator (DG); (d) Battery Storage system (BS); (e) Reverse Osmosis plant (RO); and (f) other power loads (LOAD)[1], if the system is designed to supply energy to additional units at the installation area Figure 1 shows the Schematic diagram of hybrid power system.

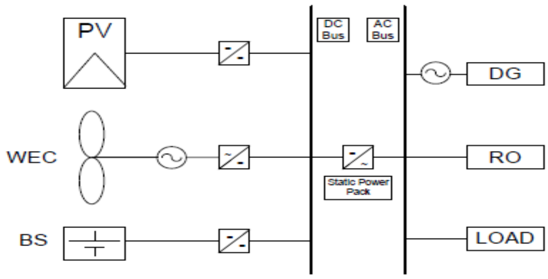


Fig. 1: The hybrid energy configuration.

3. RENEWABLE ENERGY

Renewable energy effectively utilizes natural resources such as sun light, wind, geothermal heat, biomass and wave energy which are naturally replenished. We can say that the energy comes from the sun and other natural movements and mechanisms of the environment. Renewable energy technologies range from solar power, wind power , hydro, biomass and bio fuels. But this paper use only the renewable energy sources of wind and solar energy .

3.1. WIND ENERGY

Wind Power is the conversion of wind energy into electricity. Using wind turbines, the kinetic energy of wind converted into mechanical energy by wind turbine (i.e. blades rotating from a hub) that drive generators to produce energy from wind caused by moving air masses. The movement is caused by temperature and pressure differences in the atmosphere. The exact efficiency of wind farms is nearly impossible to pinpoint. The problem is found in the factors that go into the analysis. The terrain, amount of wind, size of turbines and so on varies from wind farm to farm. There is no constant, which makes it difficult to nail down general efficiency ratings. In general, a single wind turbine will convert about 20 percent of the energy into electricity. The most efficient production occurs between 5 and 20 miles per hour of wind speed. This general 20 percent efficiency rating is roughly seven to five percent more efficient than solar power, but sunlight is constant whereas wind is not.

3.2. SPEED AND POWER RELATIONS

The kinetic energy in air of mass “m” moving with speed V is given by the following in SI units[2]:
Kinetic energy=½*m*V^2 joules ……….. (1)
The power in moving air is the flow rate of kinetic energy per second. Therefore:
Power, P=½*(mass flow rate per second) *V^2 ……(2)
If we let,P= mechanical power in the moving air,ρ = air density kg/ A = area swept by the rotor blades, m V= velocity of the air, m, Swept Area: $A = \pi R^2$…………(3)

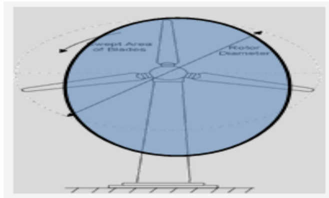


Fig .2: Model for calculating wind power.

Then, the volumetric flow rate is A-V, the mass flow rate of the air in kilograms per Second is row-A-V, and the power is given by the following:
P=½*(ρ*A*V)*V^2Watts
P=½*ρ*A*V^3Watts ……………………..(4)
Two potential wind sites are compared in terms of the specific wind power expressed in Watts per square meter of area swept by the rotating blades. It is also referred to as the power density of the site, and is given by the following expression: Specific Power of the site = ½* ρ*V^3; watts per $m^2$of the rotor swept area.

3.3. SOLAR ENERGY

Solar energy [6] is energy from the sun. Term of solar power is referred to the conversion of sunlight into electricity. There are many technologies in utilizing solar energy. In addition solar energy is available only for a part of a day, and cloudy and hazy atmospheric conditions cut the energy yield sharply. The upper atmospheric of the earth receives solar energy at a rate of 442.4 Btu per sq ft-hr ± 2 percent. The energy at the earth’s surface is $Q_a = S\eta_a$ Where Q_a= energy received at earth’s surface, Btu per sq ft-hr., S = solar constant, 442.4 Btu per sq ft-hr. η_a= efficiency of transmission through atmospheric, fraction. The transmission efficiency depends on four factors: air mass, the sun’s attitude, clouds and haze, diffuse radiation.

4. COMPARISION OF SOLAR VS WIND ENERGY

The first thing we need to ask ourselves is if we want our home to be “on the grid” or “off the grid.” This means whether we be tied to the main energy grid that runs within our area or not. In most cases, we want to be on the grid so that if we do run into too many cloudy days you won't be without electricity. The cost to totally setup an “off the grid” system can be much higher, so for the purpose of this comparison we have to compare solar panels that are tied to the national energy grid. Solar energy can be easily tapped. But we cannot tap solar energy at night and even in a cloudy day. On the other hand Wind power is at its best in the fall, winter and spring. Wind generators can produce a decent amount of energy year round; however, its benefits are offset by the space needed to have a sizable wind generator and turbine setup. Smaller versions of large-scale wind generators do exist for more residential uses. Wind is used nationwide where the wind is more consistent. One of the things that gives wind power an advantage over solar is that energy may created during storms. The wind is stronger during storms and therefore will help produce more energy than on a normal day and will help offset any loss of energy that is lacking from your solar panels.

4.1.DATA ANALYSIS OF SOLAR RESOURCE

This sea-beach has a good potential of solar and wind energy resources but till**.** Now there has no such activity to use this resource. Therefore HOMER (hybrid optimization Model for Electric Renewable), a software developed by National Renewable Energy Laboratory (NREL) .All over Bangladesh, including coastal areas and offshore sea-beach of the country, solar energy is available at good intensities (range 4 – 6.5 kWh/m2-day, avg. 5 kWh/m2-day), the total average sunshine availability being close to about 2000 h per year[11]. The data of solar radiation is given below:-

Table 1: Solar radiation data for Kuakata sea-beach

Month	Barisal	Kuakata
January	4.12	4.17
February	4.75	4.81
March	5.20	5.30
April	5.82	5.94
May	5.65	5.85
June	4.33	4.39
July	4.15	4.20
August	4.35	4.42
September	4.41	4.48
October	4.61	4.71
November	4.29	4.35
December	3.90	3.95
Average	4.61	4.71

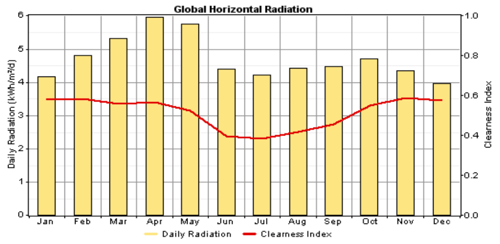


Fig.3. HOMER clearness index from the latitude information

4.2. DATA ANALYSIS OF WIND RESOURCE

Data of wind speed (m/s) & power output is given bellow for Kuakata sea-beach[11].

Table 2: Wind speed (m/s) & power output data for Kuakata sea-beach

Month	Wind speed (m/s)	Average net power output
January	5.08	45.7
February	5.29	46.2
March	5.12	41.2
April	7.19	106
May	6.98	102
June	7.24	109
July	7.79	125
August	7.55	121
September	6.08	73.8
October	4.22	29.6
November	4.28	26.2
December	4.96	40.2
Average	5.94	71.4

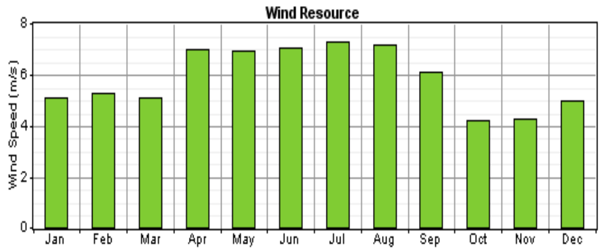


Fig .4: Monthly variation of wind speed

5.1 HYBRID OPTIONS ANALYSIS FOR ENERGY EFFICIENT SYSTEM

Kuakata is a sea-beach where renewable resources are available but the amount of nonrenewable resources is very limited. Now if we want to supply power to this island then we have to design a system where cost of energy per unit will be minimum. If we use solar resource only then it is not possible to continue power at night or if we use wind resource only then continuous power not possible because the wind does not flow all time[7]. And for peak hour, power demand will increase then this extra power we can supply use a diesel generator. So above the discussion we can understand that a system have to design where will get continuous power. So we can design a hybrid system with PV, wind turbine, diesel generator, battery, converter and electrical load. HOMER performs these energy balance calculation for each system configuration that anybody wants to consider. It then determines whether a configuration is feasible, i.e., whether it can meet the electric demand under the conditions that have been specified and estimate the cost of installing and operating the system over the life time of the project. The system cost calculations account for costs such as capital, replacement, operation and maintenance, fuel and interest.Information about the load, resources, economic, constrains, controls and other component that have been used in HOMER.

5.2 ELECTRIC LOAD

Monthly averaged hourly load demand (Bangladesh perspective) has been given as an input of HOMER and then it generates daily and monthly load profile for a year (fig 5). It has been found that for the system each home user consume energy around 0.875KWh/day with a peak demand of nearly 63W.Figure 5 shows. Monthly average hourly load profile for a single home user.

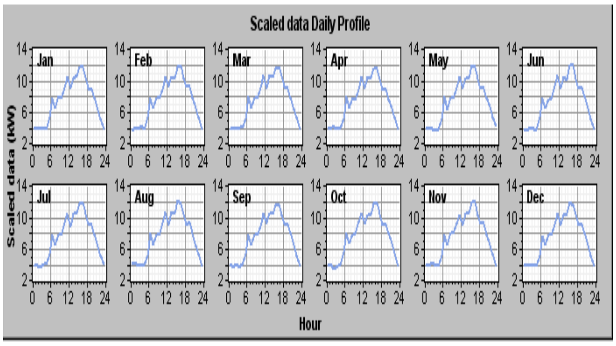


Fig.5: Monthly average hourly load profile for a single home user.

5.3: ECONOMICS AND CONSTRAINTS

The project life time has been considered to be 25 years and the annual real interest rate has been taken as 6%. As the system has been designed for single and also for multiple home users like 200 (approximately) but the load consumed by the user is low so operation and maintenance cost has been taken 1000 BDT/year. There is no capacity shortage for the system and operating reserve is 10% of hourly load. No cost subsidy has been taken.

6. SIMULATION & RESULT

DESIGN SINGLE SYSTEM BY USING HOMER

Now we are going to discuss the simulation results for a remote area such as Kuakata sea-beach. Here available renewable energy is solar, wind etc. At first we design PV, Wind & Diesel generator separately system for approximate load 180 KWh/day. The components list & figure of this system are given bellow.

6.1 COMPONENT LIST

Table 3.component list and its price

Componet	Model	Capital cost $	Replacement cost $	Operation & maintaining cost	Size (KW)
PV	Choiceable	10000	5000	1$/yr	205
Wind turbine	Enercon E 33	9000	4500	1$/yr	330
Diesel generator	Generator 10	8000	4000	3$/hr	190
Battery	Hoppecke 24 opzs 3000	400	150	1$/yr	6
Converter	Choiceable	7000	3500	1$/yr	190

(1 $ = 73 BDT)

6.2 DESIGNS FOR PV SYSTEM BY USING HOMER

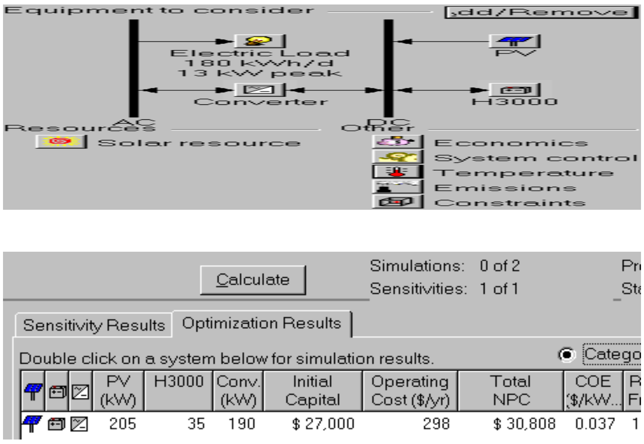


Fig .6: Proposed PV system with simulation result

6.3 DESIGNS FOR WIND SYSTEM BY USING HOMER

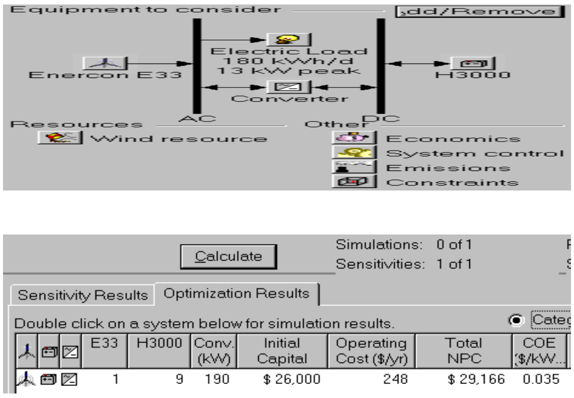


Fig. 7.Proposed wind system with simulation result

6.4 DESIGNS FOR DIESEL GENERATOR BY USING HOMER

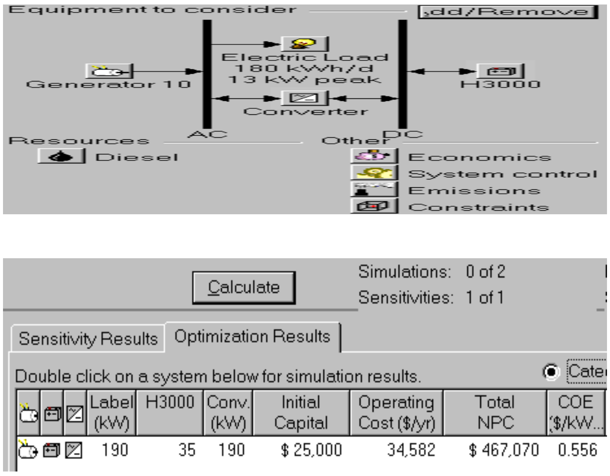


Fig .8: Proposed diesel generator system with simulation result.

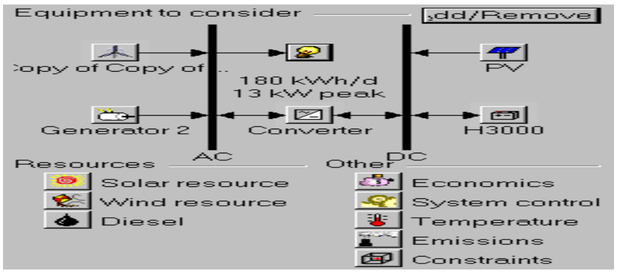
From the simulation result shown above we can see that among three systems renewable energy is preferable than nonrenewable energy. Between PV & Wind system, wind system is preferable.

6.5 DESIGN HYBRID SYSTEM BY USING HOMER

We design Hybrid system (PV, Wind & Diesel) for approximate load 180 KWh/day. The components list & figure of this system are given bellow [8]

Table 4. Component list and price

Component	Model	Capital cost $	Replacement cost $	Operation & maintaining cost	Size (KW)
PV	Choice able	10000	5000	1$/yr	205
Wind turbine	Emerson E 33	9000	4500	1$/yr	330
Diesel generator	Generator 10	8000	4000	3$/hr	190
Battery	Hoppecke 24 opzs 3000	400	150	1$/yr	6
Converter	Choiceable	7000	3500	1$/yr	190



(1 $ = 73BDT)

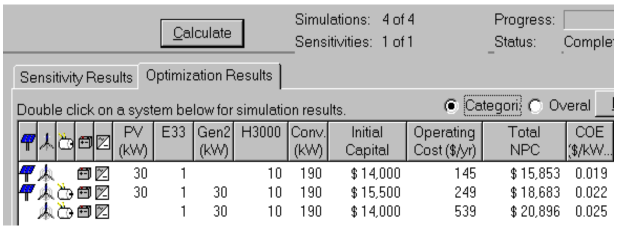


Fig. 9. Proposed hybrid system with simulation result

7. OUTPUT

From HOMER simulation we get cost per unit for various design schemes which is compared in the table given below:-

Table 5. cost per unit for various design schemes

System Design	Cost of electricity ($/KWh)	Cost of electricity (BDT/KWh)
PV system	0.037	2.59
Wind system	0.035	2.45
Diesel generator	0.556	38.92
PV & wind system	0.030	2.1
Diesel generator & PV	0.053	3.71
Wind & diesel generator	0.037	2.59
Hybrid system	0.022	1.54

Above the simulation result we can see that the for single design, combination design and hybrid system design among which per unit cost of electricity is minimum of the hybrid system.

7.1 COST OF ELECTRICITY VARIATION WITH ELECTRICAL LOAD OF A HYBRID SYSTEM

The cost of electricity produce of hybrid systems are varies from load to load.The figure 10 shows the cost of electricity variation with electrical load.

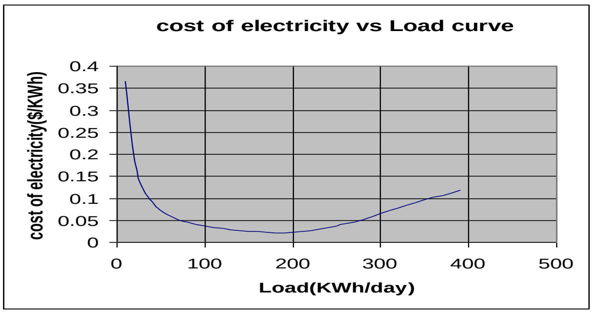


Fig .10: Cost of electricity variation with electrical load

This Hybrid system design is limited for load between 1 to 390KWh/day. If we apply the load above 390 KWh/day then its cannot calculates by using HOMER.

8. DISSCUSSION AND CONCLUSION

The proposed kuakata 180 KWh/day wind solar hybrid system will be the largest of its kind in Bangladesh. Renewable energy systems are very much site specific and designing such a system is complicated. Solar and wind system are most suitable for electrification of isolated remote areas in developing countries like Bangladesh. For this area we have designed separately solar, wind & diesel, combined system and hybrid system. It could be summarized from the above analysis we can see that, used of a renewable energy resource is very preferable for remote area because the conventional energy is not available. For this remote area better PV and wind system but we have designed a hybrid system use by renewable resources and diesel energy which per unite cost of electricity is limited (cost/pu=0.022$ or BDT=1.54) can easily used by the people of this sea-beach. So it will be better to use hybrid system for approximately 200 families.

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