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GENERATION OF ELECTRIC POWER FROM RENEWABLE SOURCES: A SELF SUSTAINABLE APPROACH FOR AN INDIAN VILLAGE

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Abstract-Today the whole world is undergoing a transformational changes and adjustments because of problem of global warming and continuously increasing production of organic wastes,which necessitate a entire world shift towards the sustainable growth. India's development, desires the unique growth of energy sector over the next decade. There is also a vital requirement of energy security. In India 60 % people's livelihood relies on the farming sector and the majority of the people lives in rural areas. Numerous of the villages are distantly situated and the connectivity with the power grid for these remote area villages is very complex which resulting in lack of uninterrupted power supply. For the progress of this region, there is a need for the expansion of Renewable energy sources of energy. In this paper a case study of Indian village "Bholana" has been taken to make it self sustainable. A comphrehensive survey of village is done to access the available renewable resources. The modelling of Hybrid Optimization Model (biomass/biogas + solar) is done with the use of (HOMER) software. This Hybrid renewable energy model is more suitable forthis village where grid expansion is considered too costly. This paper explains theconsumption of renewable energy sources in a sustainble way for the remote areas and making the village self sustainble in its energy needs.

Index Terms- HOMER, hybrid system, biogas, solar,biomass,renewable.

1. INTRODUCTION

Energy plays a vital role for the growth of a any nation and it has to be preserved in a most efficient manner. The trend of utilization of renewable energy resources and the relevant has been gradually increasing so as to fulfill the energy demand. In urban India, with luxurious life style , there is a ever increasing demand of power , but to fulfill these power demands there is shortage of power. In rural area, the power demand may be at medium level but resources are less. Over 110 million people, live in rural areas without the accessibility of electricity. The installation and distribution expenditure of power are considerably more for these remote located areas. Moreover, there is higher transmission line losses and interrupted power supply [1]. In rural areas, management of the organic waste (cattle dung) and crop residue is the main problem. The burning of crop residue is the simple method to eliminate the crop waste after harvesting but it emits harmful gases like carbon monoxide, sulphur dioxide etc.,which badly affect human health and also the environment making the soil less fertile [2]. As in present scenario, in order to provide feasible solution,investigation has been done on how these alternatives energy sources in a village can be made valuable for supplying the clean energy to the village and make village self sustained in its energy needs itself.This paper deals with the survey conducted in an Indian village, "Bholana" of district Kapurthala in Punjab, India. This village comprises of 335 houses and the energy requirements of the village based on the survey are noted below. The methodology for renewable energy sources is proposedbelow:

- Collection of data for electrical load, cattle population, bio-mass residue for village under study.
- Assessment of present consumption of electricity and available renewable reserves in village.
- Photovoltaic and biomass/biogas based hybrid energy system is proposed to fulfill the electricity demand of village and make it self sustainable.

2. PROBLEM FORMULATION

To replace the present supply source for village Bholana which is now from convention source to non-convention source is possible through the utilization of available renewable sources and managing the crop residue and animal manure. This is also the best way to provide electricity to the villagers at less price. A survey was done to find information on energy consumption, data was collected from all 335 houses in Bholana. The total cattle population and total electric load consumption as given below:

Table 2.1 The Total Cattle Population and Total Electric Load Consumption

Name of Indian Village	**Bholana,Kapurthala (Punjab),India**
Location	31.3881581''N latitude 75.3897366''E longitude
Number of house hold	335
Farmed Area (acre)	322
Cattle population	515
Average Connected load (kWh/d) Domestic Community	 3181 289

VILLAGE LOAD DATA

The power consumption of village is not so much high as in urban areas. The fundamental energy requirements in village can be classified into two sectors i.e., domestic and community. In the domestic sector electricity is required to use appliances like lamps, televisions, fans, Ac, refrigerator,cooler, heater etc. The community sector load contains medical dispensary, schools, shops and police station [2].

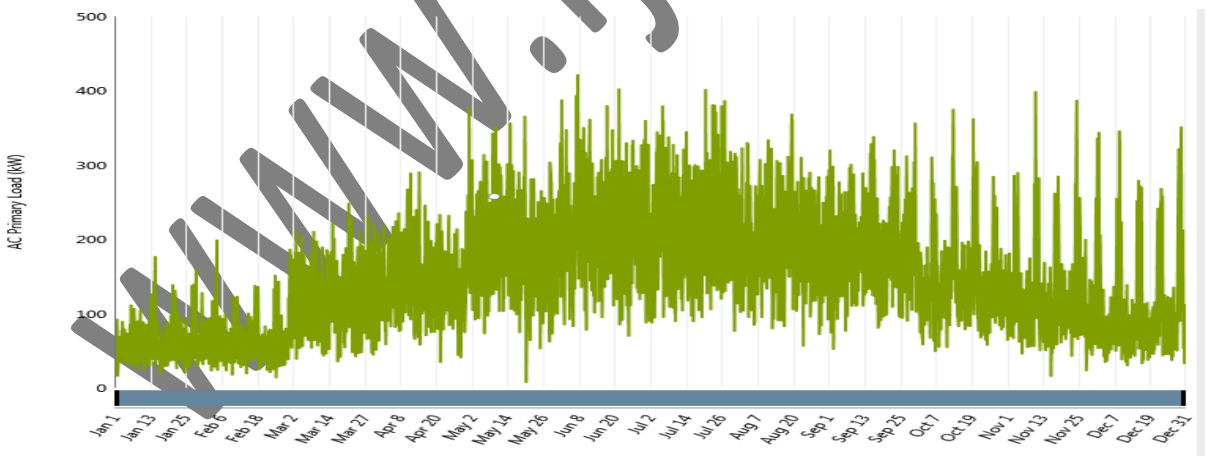

Fig. 2.1Monthly Load Profile of Village

3. PROPOSAL FOR MEETING POWER DEMAND OF VILLAGE

3.1 HOMER BASED HYBRID RENEWABLE ENERGY SYSTEM

Hybrid renewable energy system (solar + biogas/biomass) is planned for meeting the electricity needs of the village. HRES designed is based onthe certain important parameters like load profile, biogas/biomass data, solar radiations data which optimize the size & cost effectively [2]. HOMER software is used which is multi-purpose software

package used to design hybrid power systems. In order to achieve the optimum design of hybrid systems, Homer performs a large number of simulations to ensure the best possible results. Additionally, this software can analyzelife cycle costs to rank configurations in terms of costeffectiveness.

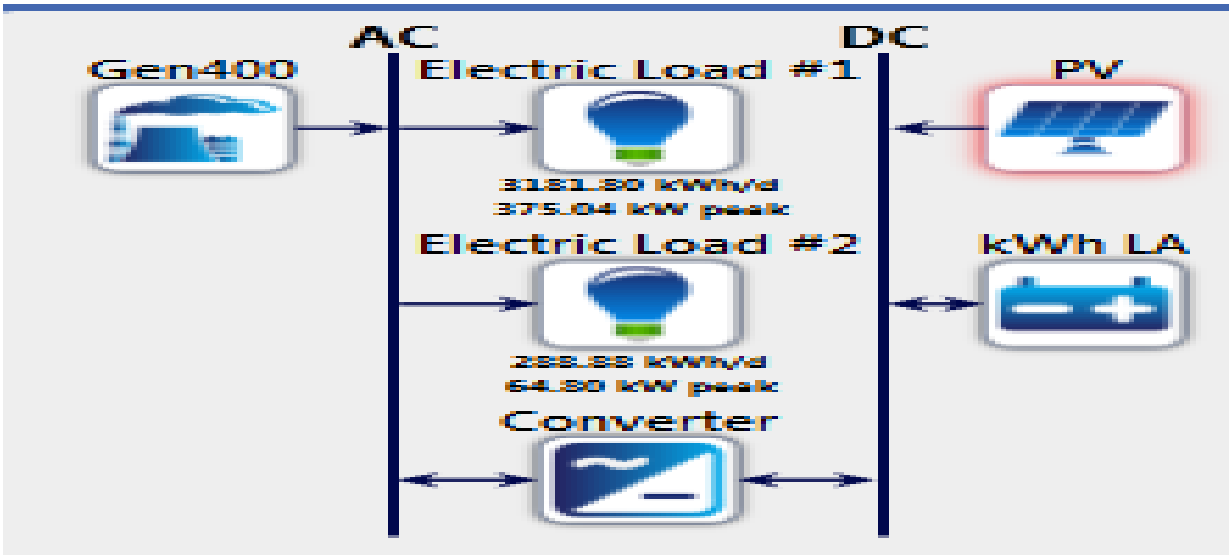

Fig. 3.1 Hybrid Power System Design by HOMER

4. AVAILABLE RESOURCES IN VILLAGE

4.1 Biogas Resource

Biogas is the enormous renewable source of energy which still remains unused. Cattle dung is the main source of biogas which is easily available in the village in a large quantity. Through various energy conversion techniques like combustion and gasification, biogas can be converted to gaseous fuel and electrical power. Biogas is produced from organic wastes and animals manure. Biogas is a clean gaseous fuel which is produced through anaerobic digestion procedure [3].

Table 4.1 Specification of Recommended Biogas Plant

Name of biogas plant model	PAU Janta
Capacity of plant	$300m^3$/day
Total no. of cattles	515
Total manure per month	154 ton
Total Cost of plant	29 lakh

4.2 Biomass Resource

As we know, being agriculture state Punjab has highest production of wheat and rice in India.The crop residue is the main source of biomass energy which is available in village in a abundant quantity. Biomass is the most budding option to supply future energy demands. The average biomass available in village is 4 .5 tons per day. Biomass can be used to generate electricity through the biomass gasification technology which converts any kind of biomass energy with low heat value (such as waste from agriculture and organic waste) into combustible gas and then feeds this gas to a generator for electricity generation.

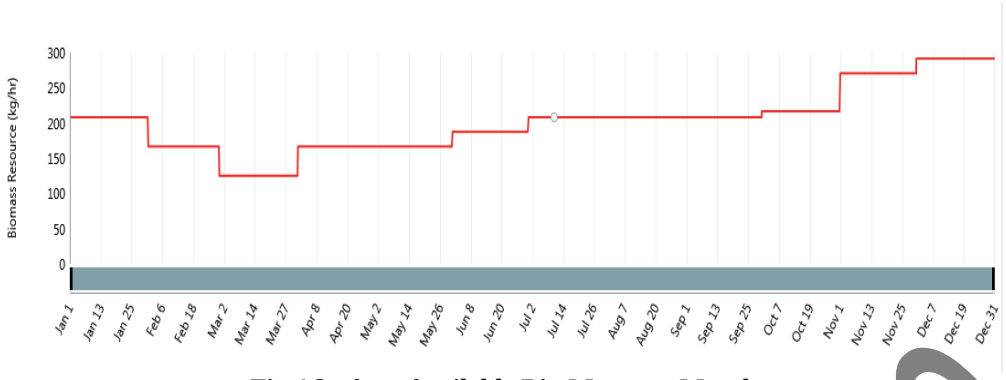

Fig.4.2 Avg. Available Bio-Mass per Month

4.3 Solar Energy

Sun is the main source of energy. It is renewable, inexhaustible and environmental friendly. India is blessed with large amount of sunshine all the year with an average sun power of 4.96 KWh/m^2/day. Solar charged battery systems provide power supply with the help of solar cells that convert sun energy directly into D.C electricity. Semiconductor materials are used to make this solar cell in PV module. The electricity generated from PV cell can be stored in a battery system. PV systems generally can be much cheaper especially to remote areas. The Monthly average solar radiations data has been taken from NASA [4]. HOMER introduces the clearness index of the selected site and the average solar radiations equal to 4.96KWh/m^2/day.

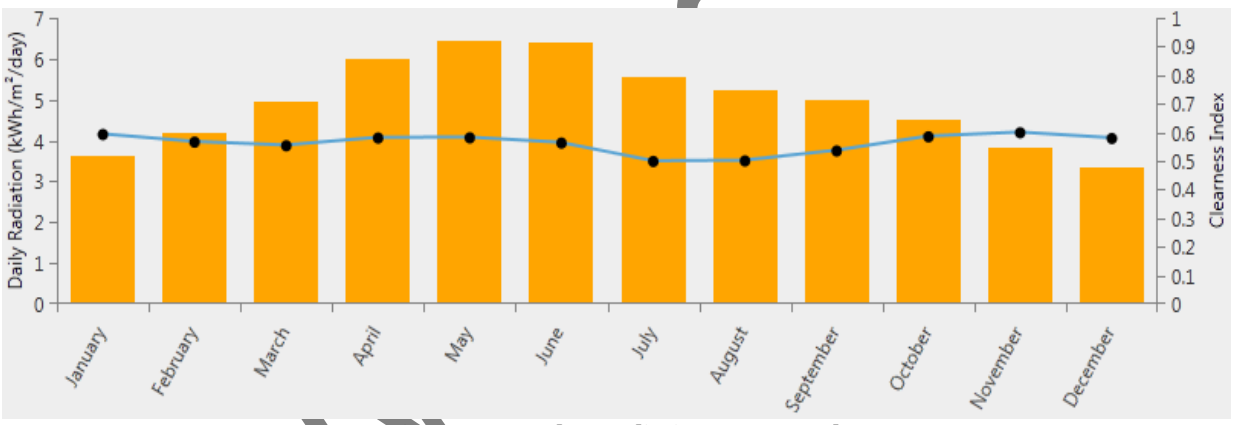

Fig.4.3 Avg. Solar Radiations per Month

5. DIFFERENT ENERGY COMPONENTS

5.1 PV Array

PV cells are used to generate electricity byconverting solar radiations into direct current electricity using semiconductors that exhibit the photovoltaic effect.The capacity of PV array system is 10KW.

5.2 Generator

Internal combustion (IC) engines which can work for both on liquid and gases fuel can be used. In this village the availability of biomass/biogas is sufficient for the 400KW generator set operation .The fuel is used for the generator is biogas. Advantage of using biogas as fuel is that it is clean fuel which reduces the contamination of engine oil and also reduces deposits on piston.

5.3 Battery

The lead acidic batteries are used in this system to store the electricity and to operate the power system when power from system is absent or insufficient. The total no. of batteries used is 20.

5.4 Converters

A solar converter is used to convert the DC power output of solar panel into the AC power and to maintain the flow of energy between dc and ac components. The 12KW size converter is used in this system.

Table 5.1 Various Components and Technical Data

Components	Capacity	Total Capital cost ($)	Total Replacementcost ($)	Total O&M Cost ($)	Life Time (years)
PV panels	10 (KW)	17000	150000	60/year	25
Generator	400 (KW)	135000	100000	0.01/hr	25
LA	20 batteries	5800	3000	.01/hr	10
Converter	12 (KW)	4800	3500	1/year	25

6. HOMER SIMULATION RESULTS

In the current scenario, the collection and sizing of components of hybrid power system has been done using HOMER software. HOMER is user friendly software which simulates each and every combination system design in the specific search space. Only the viable one will be displayed at optimization result sorted based on the combination of system components is arranged from most effective cost to the least effective cost.

Architecture								Cost					Gen400	
				PV (kW)	Gen400 (kW)	LA	Converter (kW)	COE ($)	NPC ($)	Operating cost ($)	Initial capital ($)	O&M ($)	Fuel (kg)	O&M Cost
				10.0	400	10	12.0	$0.0533	$873,316	$55,936	$150,200	$9,040	538	9,023
				10.0	400	10	12.0	$0.0533	$873,317	$55,936	$150,200	$9,040	538	9,023
				10.0	400	10	15.0	$0.0534	$874,549	$55,939	$151,400	$9,043	538	9,023
				10.0	400	10	15.0	$0.0534	$874,549	$55,939	$151,400	$9,043	538	9,023
				15.0	400	10	12.0	$0.0541	$885,584	$55,918	$162,700	$9,048	536	9,023
				15.0	400	10	12.0	$0.0541	$885,584	$55,918	$162,700	$9,048	536	9,023

Fig.6.1 Optimization Results

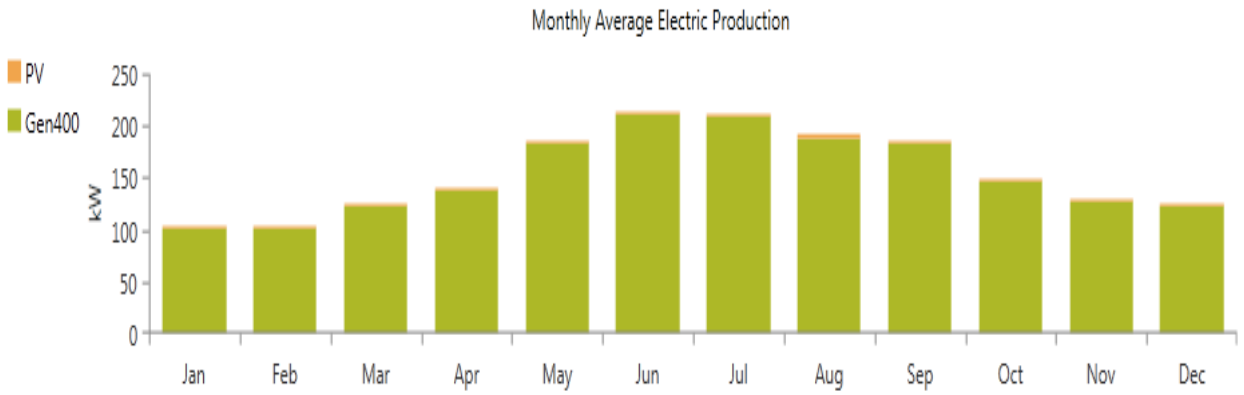

Fig.6.2Monthly Avg. Electric Production

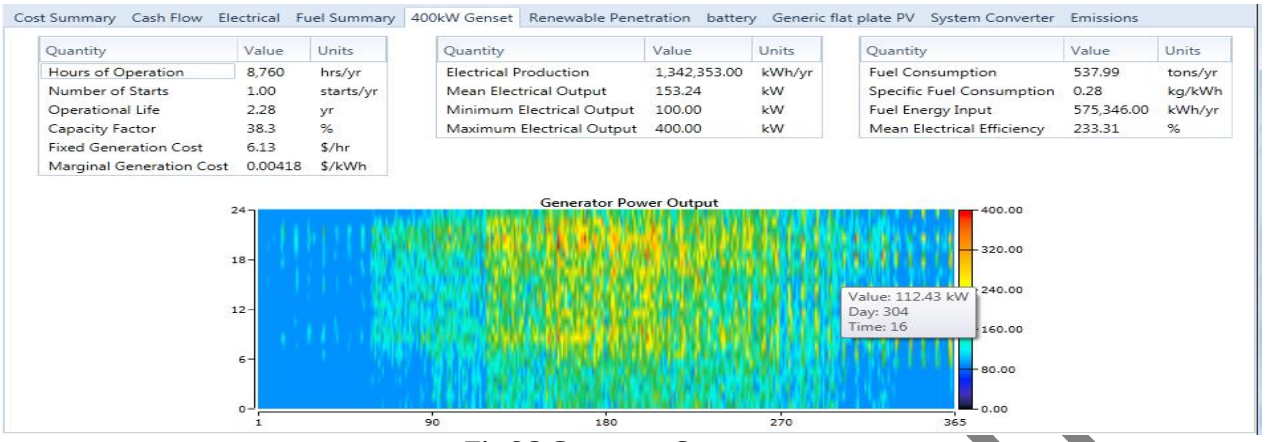

Fig.6.3 Generator Summary

7. COST ANALYSIS

To meet up the power requirements of village, a standlone hybrid renewable energy system (HRES) is proposed whose result is found with the use of HOMER software. The total capacity HRES is 410 KW which contains 10KW solar PV array system and 400KW biogas/biomass generator system, with a per unit cost of energy (COE) of $0.0533/Kwh and the total net present cost (NPC) of $873316.

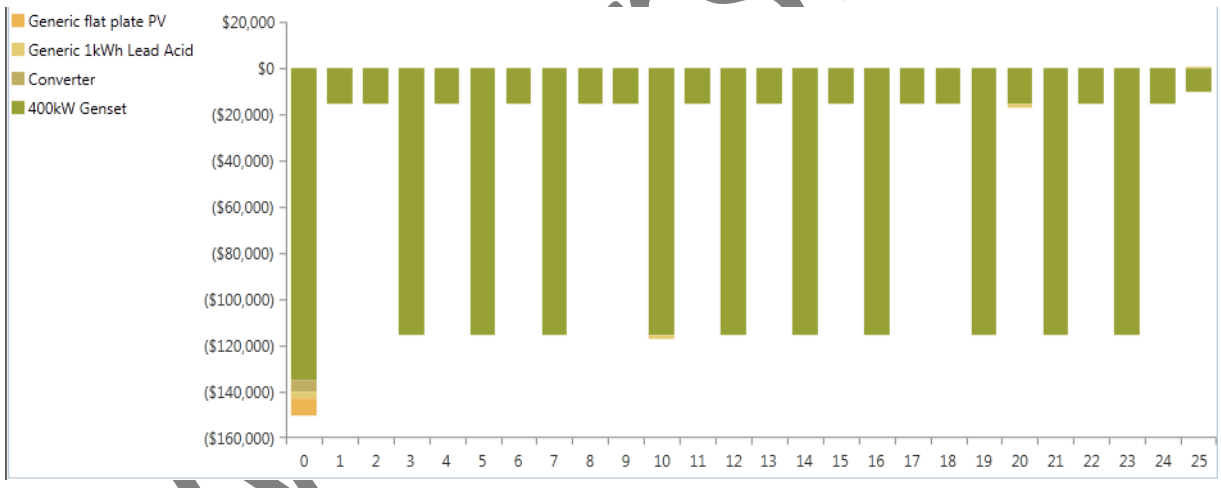

Fig.7.1Cash Flow Summary

CONCLUSION

This paper has concluded the study with problem under optimization results and effective/cost analysis of HRES using HOMER software. Hybrid energy system providing stability in power system and also providing power on environmental friendly basis. In this study total renewable sources existing in the Indian village has been assessed and a viability plan has been made as to produce electric power from these renewable energy resources. The renewable energy system has higher reliability, cost effective and also improving the quality of power supply. With the use of these resources 410 KWp power plants is proposed for the village which includes 400kW Biomass/Biogas power plant and 10 KWp Solar PV power plants and per unit cost generation is $0.0533/ kWh. The two of main problems of managing the organic waste and inconvenient power supply of village could be well overcome with the help of renewable energy resources and a first step towards the making village sustainable in its energy needs. The aim of increase the power system efficiency and increase the use of renewable sources also fulfilled. Before implementing a conventional energy sources to provide power in a site if we appraise the availability of renewable

energy resources than the whole scenario may change to a sustainable one which can be superior for us and good step towards the make environment green and clean**.**

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