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SOLAR-HYDRO SYSTEM FOR POWER GENERATION

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Abstract

The main purpose of this work is to design an optimal efficient economic power renewable energy system that feeds the required electric load. Two renewable energy power systems are presented in this paper to select the most optimum among them. These suggested renewable energy systems are PV-Hydro hybrid system, stand-alone Hydro system, stand- alone photovoltaic system. In addition, a comparison between the two different suggested power system configurations is illustrated in details. PV-wind hybrid system realized the lowest net present cost as well as the level cost of energy. Also, this system was able to provide energy approximately all the day. The battery state of charge varies from 83%upto 99% and it was found that, the PV-Hydro hybrid system is more suitable than the others for the selected site and the suggested electrical load. Increasing cost of the fossil fuel have led the emphasis on the usage of renewable energy sources as an alternative source of generation. More than 70% of the Indian population resides in the villages which are deprived of power for more than 6 to 12 hours a day. For the overall growth of the economy, it is necessary that the agro based economy also contribute to the growth. lt is neither feasible nor economical to transmit electricity in the far off regions where a few families reside in the village. Hence decentralized and distributed generation concept has come up under the Rajiv Gandhi Gramin Vidyutikaran Yojana which is implemented by Rural Electrification Corporation. The Hybrid Renewable Energy System can not only make optimum use of the available renewable resources but can become cost effective by minimizing per unit cost of generation which could otherwise be high by considering any single source such as solar, wind, biomass or small hydro.

Index Terms: *PV, Hydro Turbine, Hybrid System, Net Present Cost, Load*

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1. INTRODUCTION

Electricity requirement is increasing day by day all over the world. The power generation of electrical energy to fulfil the power requirement is mainly done with the use of fossil fuels such as oil, coal, and gas. The conventional scheme of power generation may cause depletion of the fossil fuel and degradation of environment. Because of this, the researchers are envisaging the power generation technique from the renewable energy sources such as solar, hydro, wind, and biomass. These energy sources are preferred for distribution generation (DG) system as they are abundantly, economically, and easily available. Such types of DGs have less cost with easy and less expensive maintenance.

2. LITERATURE REVIEW

The proposed a hybrid system which includes PV/Micro-Hydro/Diesel power generation suitable for remote area applications. They have designed the model to provide an optimal system configuration based on hour by hour data for energy availability and demands. They are also found based on simulation results that the renewable/alternative energy sources will replace the conventional energy sources and feasible solution for remote and distant locations [1].

Authors have discussed about the fact that if appropriate renewable energy sources are selected and used complementarily, the overall performance and potential supply time are anticipated to exceed those obtained by the individual use of these resources. The study they carried out is on the complimentary operation system, consisting of PV and hydro systems. Homer software was used to illustrate and evaluate the technical and economic aspects of the hybrid system [2].

An attempt was made by the author to explore the possibility of utilizing power of the wind and sun to reduce the dependence on fossil fuel for power generation to meet the energy requirement of a village in Saudi Arabia. In their study they adopted wind/PV/diesel as hybrid system with 35% renewable energy penetration (26% wind, 9% PV) and 65% diesel power contribution as the most economical power system. They concluded after estimation that the cost of energy of diesel power system was found more sensitive to diesel price than the cost of energy of hybrid power system [3].

3. MATHEMATICAL MODEL

3.1 Mathematical Model of a PV System

The electrical characteristics of PV modules are generally represented by the current v/s voltage (I-V) and the current v/s Power (P-V) curves. The I -V characteristics of a PV module are given by

$$I = I_L - I_0 ([e (V + IR_s)] NKT/ - 1)$$

Where, I_L = Photo current

I_0= diode saturation current
R_s= series resistance q= charge of electron k= constant

T= temperature

N= no. of PV module

Power output from the PV array can be obtained by using the

Equation

$P_{PV} (t) = INS (t)* A *Eff. (PV)$ (la)

Where INS (t) = insolation data at time t (kW/m2), A= Area of single PV panel (m2), Eff. PV = overall efficiency of the PV panels and OC-OC Converters.

$PS= \eta I SN$

Where, η and I are the energy conversion efficiency, generation power per m2 for 1 MJ/m2, and insolation in kW/m2. Also the initial and maintenance cost of PV panels per year can be expressed mathematically as follows:

$S = [S_e S_n / S_y] S_{mc}$

$=S_{IC} (1-\lambda S) S_n / S_y$

Where, SC is the cost /m2 of PV panel, λ s is the reliability coefficient of PV panels, SY is the lifetime of PV panels SN is the number of PV panels to be determined.

3.2. Mathematical Model of Micro Hydro

Power equation for a hydro turbine unit is:

$PG = 1000QH / 102 = \eta_G \eta_T$

Where, P_g is generated power in kW, Q and H are Flow rate m3 /s and Head (m), η_G η_T are the generator and turbine efficiency respectively

4. BASIC BLOCK DIAGRAM

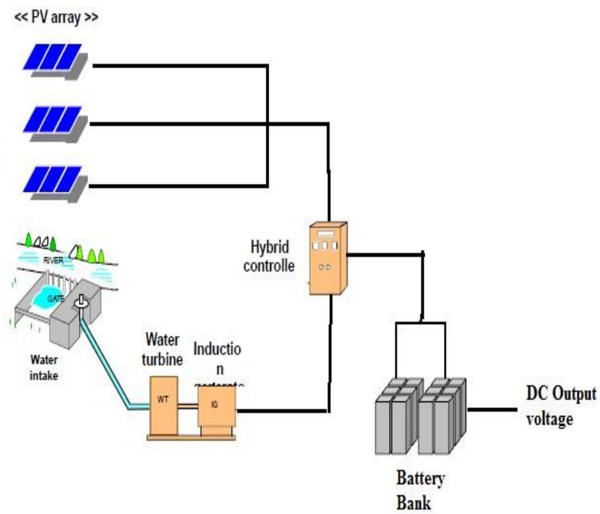

Fig-1: Basic block diagram

4.1 PV array

The photovoltaic array can convert solar energy into proportional electrical energy. Here PV panel in that PV module is connected in series manner. A high valued capacitor CB is connected across the PV panel terminal to reduce the harmonics, which is generated due to variation in temperature and solar irradiation. Here we use 10W solar panel. Output voltage of PV array is 21 V (max).

4.2 DC generator

Direct-current motor are build the same way as generator are consequently, a dc machine can operate either as a motor or as a generator. It is convert mechanical energy into electrical energy. We are use 1000 rpm dc motor.

4.3 Battery

Mainly battery is used for storing purpose. Output of the battery is 12V, 1.2 A. The main purpose of battery is give continuous supply to the output.

4.4 Charging circuit

The main purpose charging circuit is converting pulsating dc into pure dc as well as voltage regulation occur. We are use two charging circuit one is for solar panel and second one for hydro system. It contains diode, capacitor, regulator, potentiometer, resistor, zener diode, NPN transistor.

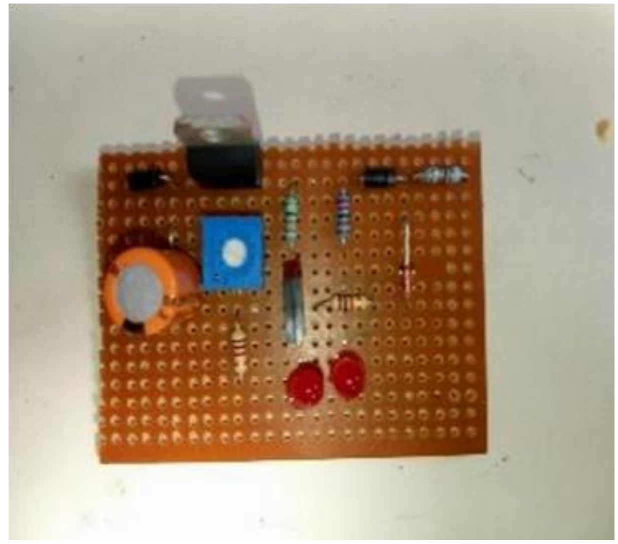

Fig-2: Charging circuit

5. SIZING OF SOLAR PHOTOVILTAIC SYSTEM AND MICRO HYDRO SYSTEM

5.1 Sizing of Solar Photovoltaic (SPV) System

Solar energy is abundantly available in the nature and this can be extracted by using the combination of series and parallel connection of solar cells forming an array. The purpose of the sizing of the SPV system is to calculate the number of solar modules and batteries needed to reliably meet the load requirement of a given area throughout the year. The sizing of the SPV system is vital from the aspect that the per unit cost of generation is highest in case of the SPV system .The sizing of the SPV system will require the solar radiation data of the area for at least one year, load of the area and the supply continuity. In case of the grid connected system, the cost of the batteries is excluded and in case of a stand-alone system, the autonomy of the battery is to be decided as per the load requirements in the night hours.

5.2 Sizing of Small / Micro Hydro system

For considering small Hydro in the HRES the source of water such as a run of river or a waterfall or any other source is the most essential requirement without which small hydro system cannot work. Hence, which considering this source the various parameters such as head or height, discharge, availability in number of months etc. of the site should be thoroughly studied. Also this source should be judiciously sized as there are lot of environmental constraints attached with the hydro power generation, otherwise the per unit cost of generation is higher in the initial years but the pay back is reached faster in this type of plants.

Fig-3: Hydro system

6. MODEL DESIGN

Model design consists of various segment such as charging unit, solar unit and hydro unit. All the above mentioned units have been prepared as per the calculations of the need. The design has been developed through rigorous analysis of the parameters involved in the same.

Fig-4: Solar system

7. CALCULATION

Table-1: Solar calculation

Sr. no.	Time period	Voltage
1	9am to 12pm	11.4
2	12pm to 3pm	12
3	3pm to 6pm	10.8

8. CONCLUSION

In this paper, analysis of solar and hydro systems has been done. The proposed system is implementable to those areas where the solar and hydro energies are available at moderate nature such as Indian circumstance. The nature of the solar and hydro energies is intermittent. Hence, using the individual system the continuous power generation is not possible, and it will also increase burden to the grid. The proposed system is able to supply the community in all seasons. In rainy season, the grid connected hydro system will feed the AC power to the consumers and in summer grid connected solar system will supply power. In other season both systems will supply the power to the consumer. The proposed system reduces the complexity of the electrical system, having less cost as compared to other RESs and reliable operation. The control of interfacing solar and hydro inverters is provided through the constant current controller. As compared to phase and amplitude control, constant current controller offers reduced cross-coupling between the real and reactive power control loops, greater immunity to phase measurement errors, better transient response, reduced current harmonics, and inherent overcurrent protection. The obtained results show that the proposed system has the potential to supply the local community.

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