

Design and Feasibility of Combined Biomass Biogas and Solar Power Plant for Generation of Electric Power

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Abstract - This includes the study of combined solar, biogas and biomass hybrid system for generation of electric power. This will help to overcome from global warming effect and statistical impact on prosperity and dependency. Increasing electricity demands, hike in fuel prices and environmental concerns are the main factors which motivate the use of renewable energy in India. In the hybrid system energy has a higher reliability, can be cost effective and improves the quality of life in rural areas. Hybrid power system aims to increase the system efficiency and use of renewable energy based hybrid power system. In order to meet the sustained load demands, different renewable energy sources need to be integrated. In this study we will integrate biomass, biogas and solar energy for generation of electricity, the composite produced will be less and cost per unit of electricity generated will be less comparatively. Solar energy is free of cost, installation cost of solar power plant is high but its operating cost is almost negligible. This paper discuss the renewable biomass biogas and solar pv combined power generation system in northern India to overcome those problems which occurred when they operate standalone.

Keywords - Biomass Power, Hybrid Plants, Biogas Power, Renewable energy, Rural area electrification, Solar PV Power.

I. INTRODUCTION

In India, the most important resource of economic development is Energy. Industrialization and urbanization has led to rapid increase in energy demand. Due to increase in demand of electric power we have need for the growth of non-conventional methods for generation of electric power.

A. Availability of Resources

As materials used for these methods are easy available, cost of electricity will be lesser. Several alternative sources of energy are being thought of, including the nuclear, solar, geothermal, wind, tidal, biogas and the biomass based. Presently, standalone solar photovoltaic systems, biogas and biomass systems have been promoted around the globe on a

comparatively larger scale. But they are facing a lot of problems during their operation. Like, in solar plants, solar panels are too costly, energy only produced during daytime and in sunny weather. Similarly, biomass plants may save on carbon dioxide emissions, but it increases methane gases, High ash content, and heat release into environment and in biogas plants some pollutants are produced. So to get optimal generation conditions, we could use the combined operation of the biogas, biomass and solar power plant.

B. Hybrid Power Plants

Hybrid systems are usually a combination of photovoltaic with wind turbines and/or generators running on diesel or bio fuel/biogas is also used. Power generated by PV array during the day is stored in the battery bank through an energy manager, which controls the complete system. Diesel generators are expensive to run and also require frequent maintenance support. A judicious mix of solar and other renewable technologies coupled with a diesel generator/grid can offer a techno-commercially viable solution that will power the backbone of rural connectivity. The resultant hybrid system thus offers an optimal solution at a substantially lower cost. It is ideal for electrification of remote villages in India. The other form of power generation is usually a type which is able to modulate power out function of demand. India is equipped to offer reliable off-grid and hybrid solutions energy needs for small area especially rural areas where powering critical loads are often a challenge. However if more than one form of energy is to be used which can be solar/biogas/biomass, the photovoltaic power generation serves to reduce the consumption of non-renewable fuel.

II. COMBINED BIOMASS BIOGAS AND SOLAR PV SYSTEM

A. Methodology

We will collect the information about the place of work including location, total area, population and the raw material available from the surrounding villages for bio-gas and biomass generation and the Solar Radiation Data of the place where the plant is to be installed is collected. Secondly we will

study about the energy requirements and related problems faced which includes electrical requirements and present modes of energy sources, problems involved by use of conventional sources and its remedial measures. Next step will be design of the biogas generation plant which includes generation technique as well as its plant calculations, selection of fuel engines i.e. types of engines, effect of temperature, digester design, height of digester and technology description. The cost evaluation of the plant is also one of the most important factor to be estimated which includes annual plant cost, cost of electricity generation, subsidy provided by government, payback period etc factors. Then selection of batteries, voltage regulators and DC control units etc for hybrid generation. In next step for biomass plant, collecting experience of farmers, Specification of the electrical equipment required is to be worked out. Calorific value of biomass particles by Bomb calorimeter. Then finally the whole area will be supplied power with the help of Micro Hybrid solar biogas and biomass Power

material for biomass power plant can be made available. Average solar radiation at the site is 5.11kWh/m²/day, therefore the site has also a great potential to generate electricity through solar power plant. Three project models, one is of biomass power plant of 1000kW, second is of biogas power plant of 300kW capacity and the last is of solar power plant of 50 kW capacity are hence proposed.

III. RESULTS AND DISCUSSIONS

A. Percentage Overall Generation

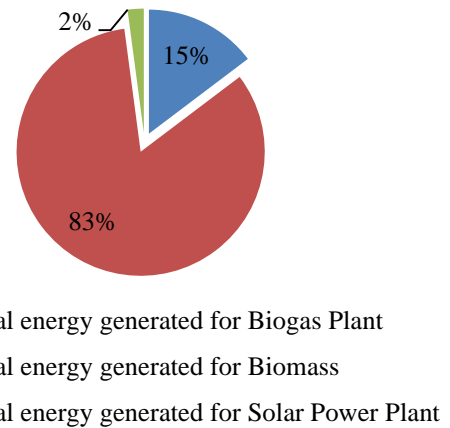


Fig.2 Percentage overall generation

B. Block diagram of Hybrid Power Plant

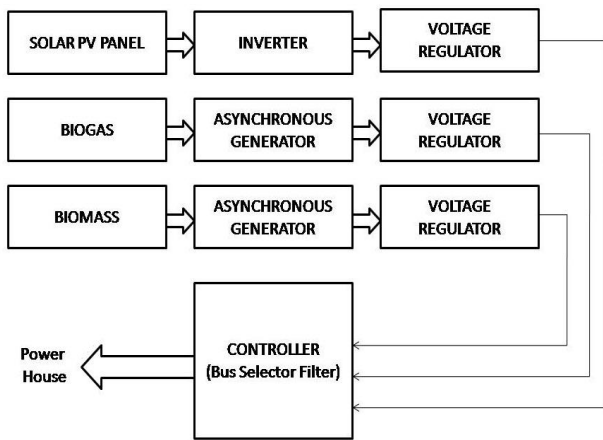


Fig.1 Hybrid System

Different parts of the Combined Biomass and Solar power system are:

- Solar PV Plant
- Biomass power plant
- Biogas power plant
- Inverter
- Controller

C. Present Work

The site proposed for hybrid power generation is Canal View Enclave (JLPL Pvt Ltd) Southern Bypass in Block Dehlon in Ludhiana, Punjab. The villages surrounding the site are Gill and Sangowal also there is a Cow herb (Gaushala) from where the raw material for the plant can be made available .The total number of cattle in the surrounding villages is 2043.The site i.e. the colony and the surrounding villages has abundant quantity of human waste and animal dung, which can be used to generate electricity by installing biogas power plant. Also, from villages of dehlon block, raw

B. Per Unit Costs

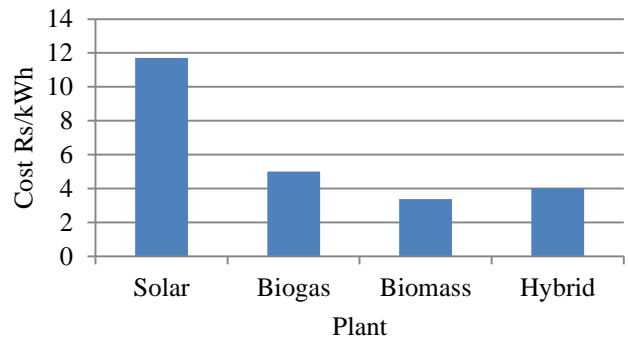


Fig.3 Per unit costs

C. Payback Periods

Payback period of all the three power plants has been represented by a bar graph in this paper in Fig.4. It shows that biomass power plant will provide free electricity in a lesser period as comparison to other two elements of hybrid system. The payback period of solar power plant is greater as comparison to others, but it will be recovered by the combined system as the cost of per unit generation will be reduced to a reasonable level.

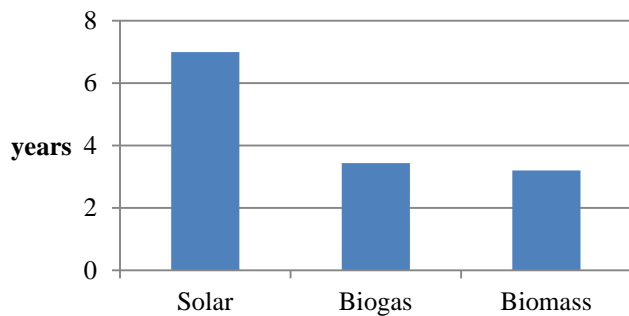


Fig.4 Payback Periods

IV. CONCLUSION

This study provides a newly approach to renewable technologies and their potential in developing countries like India. This study includes power generation from Biomass Biogas and Solar PV power plants. By use of this study, 1350 kW_p power plant could be set up in the rural areas of the northern India which includes 1000 kW Biomass power plant, 300 kW Biogas power plant and 50 kW_p Solar PV power plant per unit cost generation is Rs. 4.08/ kWh. It utilizes solar energy and; biomass and biogas as fuels in a combined cycle power plant to provide clean energy. It can be concluded that solar, biogas and biomass hybrid system is a viable green technology source for rural electrification. This study presents a biased solution for small to medium scale power generation using non-conventional energy in developing nations.

V. REFERENCES

- [1] Gupta A., Saini R. P., M. P., "Hybrid Energy System for Remote Area An Action Plan for Cost Effective Power Generation" Region 10 Colloquium and the Third ICIS, Kharagpur, INDIA December 2008 8-10. Paper Identification Number – 274.57
- [2] Ganguli S., Singh J., "Estimating the Solar Photovoltaic generation potential and possible plant capacity in Patiala" international journal of applied engineering research, dindigul, Volume 1, No 2, 2010, research article ISSN 09764259
- [3] Hua Guanghui and He Weiguo, "The status of biomass power generation and its solutions in our country", International Conference on Advanced Power System Automation and Protection (APAP), pages 157-161, 2011
- [4] Koh P.L., Pomarico V., Tadepalli V.P., Rojas- Solorzano, Luis "Pre-feasibility study of a biogas plant for Peyrelevede community" International Renewable Energy Congress November 5-7, Sousse, Tunisia, 2010.
- [5] Gu P., Tao L., Li G., Tao L., Chen J., "An Experimental Study of Rice Straw Biological Pre treatment to Produce Biogas" IEEE, 2011.
- [6] Chauhan Suresh, "District wise agricultural biomass resource assessment for power generation: A case study from Indian state,

Punjab", Original research article Biomass and Bioenergy, Volume 37, Feb 2012, Pages 205-212, Elsevier.

- [7] Guanghui Hua and Weiguo He, "The status of biomass power generation and its solutions in our country", International Conference on Advanced Power System Automation and Protection (APAP), pages 157-161, 2011.
- [8] S. Hasan Saeed, D.K.Sharma "Non-Conventional Energy Resources" Publication Kataria and Sons.