Cost Effective Micro Hybrid Power Plant with Rational Fuel Feeding Arrangement

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***Abstract*—This thesis in study proposes the hybrid system for stability which consist of a solar photovoltaic and biogas system for generation of electricity. This is to overcome global warming effect, economic and statistical impact of prosperity and dependency. In the hybrid system energy has a higher reliability, can be cost effective and improve the quality of life in small towns and scattered population where the distribution of energy becomes costly and efficiency is reduced so to overcome this problems we try to design a hybrid system which will meet our demand and will be environmental friendly. This process of hybrid energy is a new concept and it is expected that it has great future. As today's world needs energy and the energy should be environmental friendly and it should reach each and every person throughout the globe. Therefore to meet this type of demand we have to see what type of non conventional resources are available in which part and depending on this we have to design the generation of energy. As we know that any of the non conventional source is not 100% reliable so to increase the reliability we go in for hybrid energy.**

Keywords*— *Hybrid System, Renewable Energy, Reliability, Environmental friendly

I. INTRODUCTION

Due to the new regulations about self production of energy from renewable sources of energy we are concentrating on above stated different sources of energy. Depending on these sources availability at any part of the world, we are trying to have our energies from above stated sources. But due to some technical problems of these sources individually we are not able to depend on them reliably for energy. As we have two parts of energy load, the base load and the peak load now depending on the different sources we try to generate or have a hybrid source to meet our base load and peak load together. Now depending on the availability of the non conventional sources we have different combinations in different regions example could be solar with wind, solar with biomass, solar with biogas etc. Depending on the conditions of north India which has large amount of solar energy and large rural population with huge number of domestic animals. So this paper deals with the solar energy in combination with biogas energy to show that we can attain self reliability at the village level or a cluster of few villages.

A. Bio-Energy

The organic carbon based material of plants and animals is called biomass. This biomass may be transformed by physical, chemical and biological processes to bio-fuels. In chemical form biomass is stored solar energy and can be converted into solid, liquid and gaseous energy carries as shown in Fig. 1.1. (The dry matter of biological material cycling the bio-sphere is about $250x10^9$ t $y^{-1,}$ incorporating about $100x10^9$ t y^{-1} of carbon. The associated energy bound in photosynthesis is $2x10^{21}$ J $y^{-1.}$ Of this about 0.5% by weight is the biomass used for human food). The use of bio-fuels, when linked carefully to natural ecological cycles may be non-pollution and sustainable. The energy obtained from the bio-fuels is called the bio-energy. The bio-gas technology dealing with bio-chemical route of bio-energy is called biomethanation.

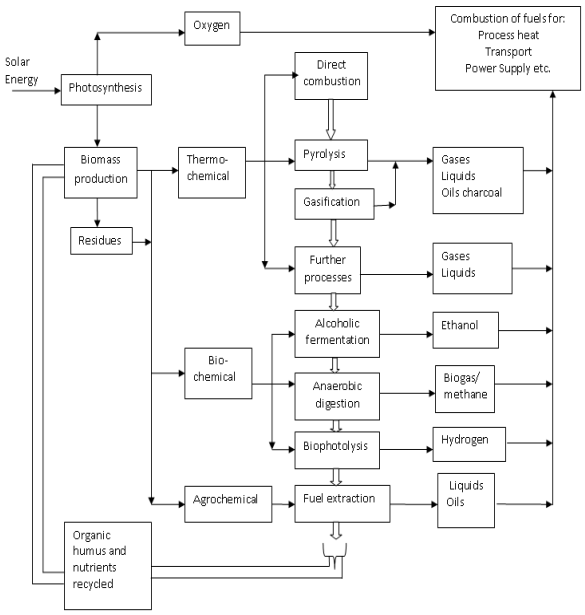

Fig.1: Process block diagram of Bio-energy

B. Solar Energy

The Earth receives 174,000 terawatts (TW) of incoming solar radiation (insolation) at the upper atmosphere. Approximately 30% is reflected back to space while the rest is

absorbed by clouds, oceans and land masses. The spectrum of solar light at the Earth's surface is mostly spread across the visible and near-infrared ranges with a small part in the near-ultraviolet. Most people around the world live in areas with insolation levels of 150 to 300 watts per square meter or 3.5 to 7.0 kWh/m2 per day.

Converting of solar energy into other forms of energy is done by two methods.

- Solar Photovoltaic method
- Solar thermal method

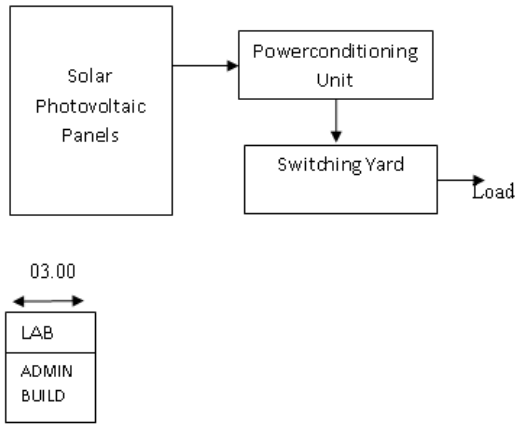

Fig.2: Schematic layout plan for micro solar photovoltaic power plant

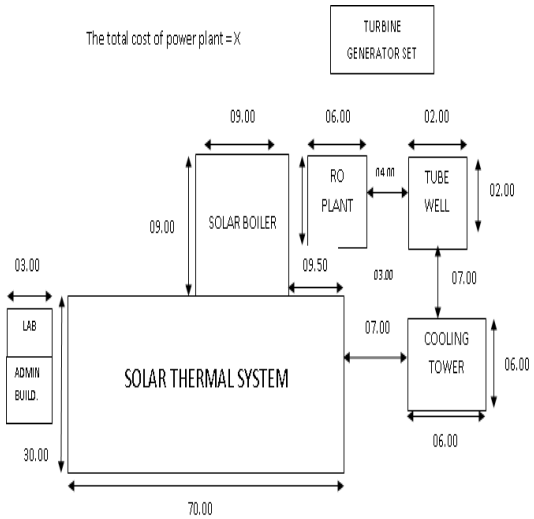

Fig.3: Schematic layout for micro solar thermal power plant

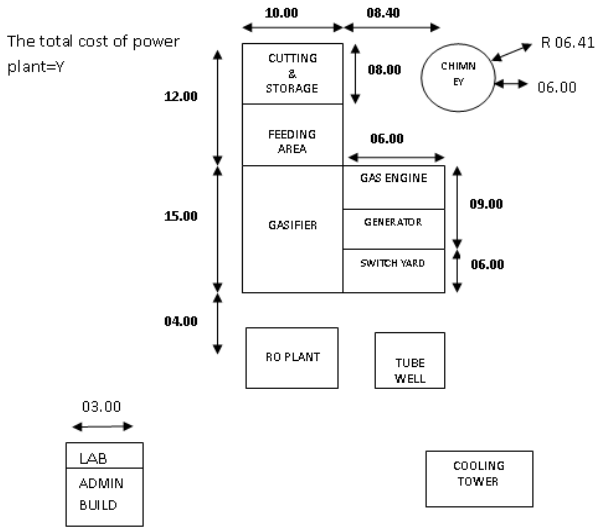

Fig.4: Schematic layout for micro bio mass power plant

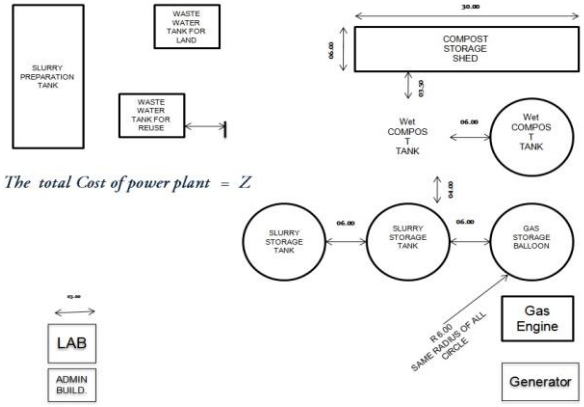

Fig.5: Schematic layout for micro bio - gas power plant

II. DISADVANTAGES OF SINGLE RESOURCE FUEL INPUT SYSTEM

All single resource fuel input power plants have their own reasons for overall poor performance hence disadvantageous. e.g.

1. Solar thermal fuel cannot be used after sunset, the heat preservation arrangement is must for 24 hour power generation, possibly at substantial increased cost.
2. Bio-gas production in sufficient quantity will require large quantity of cow dung, kitchen waste etc. Moreover rearing of proportionately large number of cattle and their dung collection is a problem in itself
3. The procurement, transportation and storage of bio-mass in required quantity has many problems .*The ash disposal* is bigger problem for a power plant more than 250 KW

Similar rules apply to other non- conventional resources such as photovoltaic, wind, and geo-thermal. So the Algebraic Formulae should be applied to overcome the drawbacks and to ensure 24 hour power generation.

III. BASED ON THE FUEL AVAILABLE AT VILLAGE LEVEL,OPTIMUM SIZE OF MICRO HYBIRD POWER PLANT

A. *Fuel requirement for 100 KW power plant*

- Solar Thermal: Available for 6 hours on an average
- Photovoltaic: Available for 6 hours on an average
- Requirement BIO-MASS: 1.5Kg/KWH
- Daily 1.5x100X24=3600 Kg
- Monthly 3600x30=108000 Kg
- Yearly 108000x12=1296000 Kg
- Available Bio-Mass: -
  - Cotton Stalks -1500Kg/acre
  - Mustard - 1200 Kg/acre
  - Guar Residue -1500 Kg/acre
  - Paddy Residue -2400 Kg / acre
- Ash content – 6 to 10% (most of it is Potash)
- For bio-gas:
  - Cow Dung 30-35 Ton Daily
  - No of Cattle -3000 to 3500
  - Residue as Compost -4 Tone

Note 1: Bio-Mass of 3600 Kg/day meaning 2 acre crop residue/day, 730 acre/year. If the size of plant is increased to 250 KW, then it is 5 acre/day, 1825 acre/year. Any village shall not have land more than 2000 – 2500 acre. If the entire residue is to be exclusively used for this purpose (which is not possible), then a Bio-mass plant of 250 KW Capacity could be installed.

Note 2: Any village of 100 houses do not have 3000 – 3500 cattle, it is not possible to generate 24 hours power by using dung only so, to produce sufficient quantity of bio-gas additional ingredients such as Kitchen waste, etc shall have to be added.

From above it can be concluded that single resource power plant is not viable in any village but Hybrid power plant of 100/200/250 KW can be installed and operated with the available fuel in a particular village/ location.

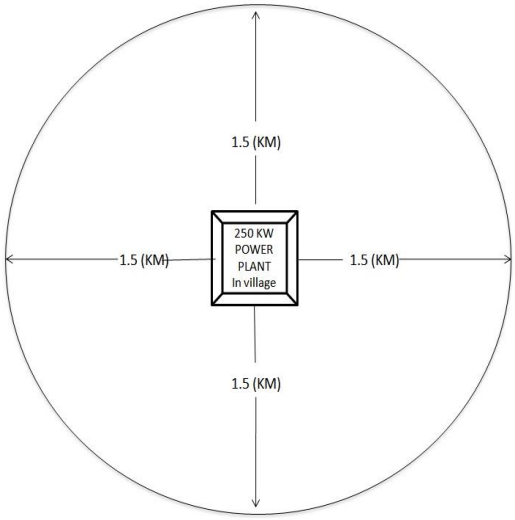

Fig.6: Boundary of one village

For the same power generation, the Diesel consumption increases many folds in case of Larger Power Plant as compared to village level Power Plants. Thus, India will not be benefited.

Since more diesel shall be consumed which will increase carbon generation/ global warming, so World as a whole shall not get any benefit from non conventional power generation.

IV. DISADVANTAGES OF HYBRID SMALL POWER PLANT

1. The land required for 1 MW Power Plant is only 2 times the land required for 100-250 KW.
2. The capital cost of Bio- Gas & Bio-Mass part shall not increase proportionately to the increase in size of Power Plant.
3. The number of employees shall increase for every Power Plant so the pay bill shall increase disproportionately

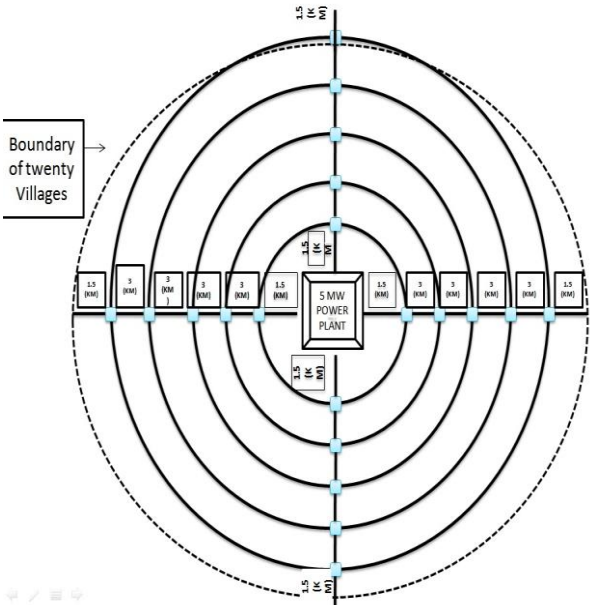

Fig.7: Model of micro hybrid power plant

Table-1: Comparison of diesel consumption for transportation of raw material to bigger hybrid power plant viz-a-viz village level micro hybrid power plant

Sr. NO	Size of PP (KW)	Fuel Requirement in 24 Hours @ 1.5 Kg / KWh	Average Distance Travelled Per Trip (KM)	No. of Trips	Total distance Travelled in a Day (KM)	Diesel Consumption per day .A tractor trolley consumes 3 liter to travel 20 (KM) Per hour.	No. of Villages	Total Power Generated	250 KW PP in each village/ No. of PP	Average Distance Travelled Per Trip (KM)	No. of Trips	Total distance Travelled in a Day	Diesel Consumption per day .A tractor trolley consumes3 liter to travel 20 (KM) Per hour.
1.	250	9 Ton	0.75	6	(6 x 0.75) =4.5 (KM)	4.5 / 20= 0.225* 3= 0.675	1	250 KW	1	0.75	6	4.5 (KM)	0.675
2.	1000	36 Ton	1.5	24	36	5.4	4	1000 KW	4	0.75	24	18	2.7
3.	2000	72 Ton	3	48	144 (KM)	21.6	8	2000 KW	8	0.75	48	36	5.4
4.	3000	108 Ton	4.5	72	324	48.6	12	3000 KW	12	0.75	72	54	8.1
5.	4000	144 Ton	6	96	576	86.25	16	4000 KW	16	0.75	96	72	10.8
6.	5000	180 Ton	7.5	120	900	135	20	5000 KW	20	0.75	120	90	13.5

V. ALGEBRAIC FORMULAE

More than two non-conventional resources of power are not available at same location in the world, (three-four resources are available in north Indian states only) so the rationale combination of two or more than two resources has not even been experimented).

The Algebraic Formulae for the cost of multi resource fuel input arrangement:

$$C = X - \frac{(n-1)X_7 + Y_7 + Z_7 + \ldots\ldots\ldots + n_7}{n}$$

Any number of inputs are possible subject to : $X_1 = Y_1 = Z_1 \ldots\ldots\ldots = n_1$

$X_2 = Y_2 = Z_2 \ldots\ldots\ldots = n_2$

$X_6 = Y_6 = Z_6 \ldots\ldots\ldots = n_6$

Note:-If any of the conditions is not satisfied even then the formulae is applicable but the capital cost of the plant shall increase proportionately

Where "n" is number of inputs

Although the combination of bio-gas, bio- mass and solar thermal have not been tried anywhere in the world but the combination as per proposed ALGEBRAIC FORMULA shall be possible, which will be much more efficient, cost effective and successful by all means.

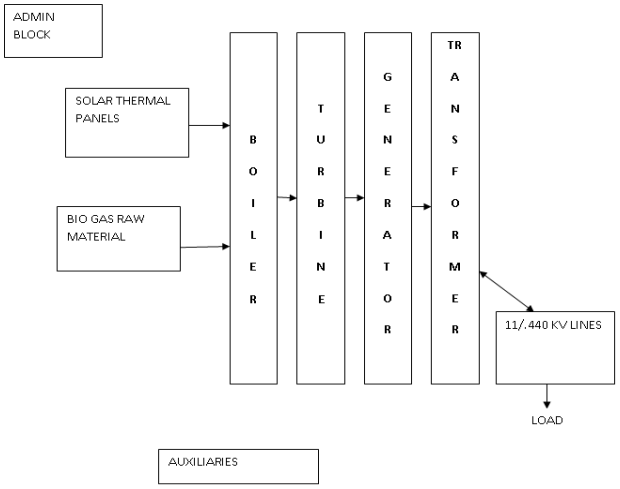

Fig.8: Schematic layout plan for hybrid (two resource fuel) power plant system

VI. BENEFITS OF THE PROPOSED MICRO HYBRID POWER PLANT

1. The gestation period of micro hybrid power plant is short (Six months only) as compared to macro power plants (Two to Three Years).
2. Partial completion possible i.e. once one resource of energy work is completed, the power generation starts the second - third resources could be added later. This could be used as peak load generation.
3. The flexibility & dependability increases with the increase in number of such power plants at village level.
4. No need of fuel storage as the fuel shall be available throughout the year, in the village itself

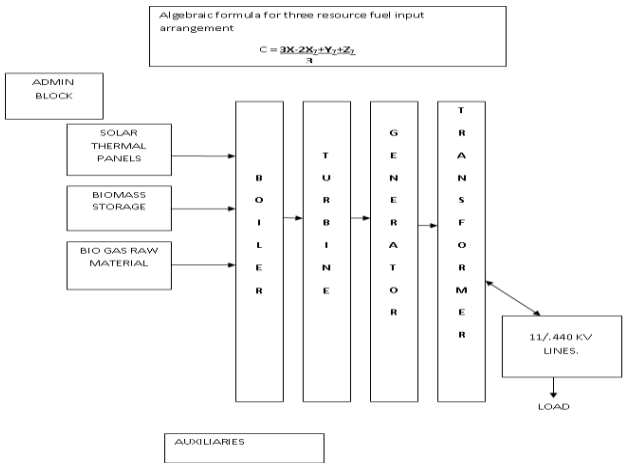

Fig.9: Schematic Layout plan for Three Resource Fuel Input arrangement

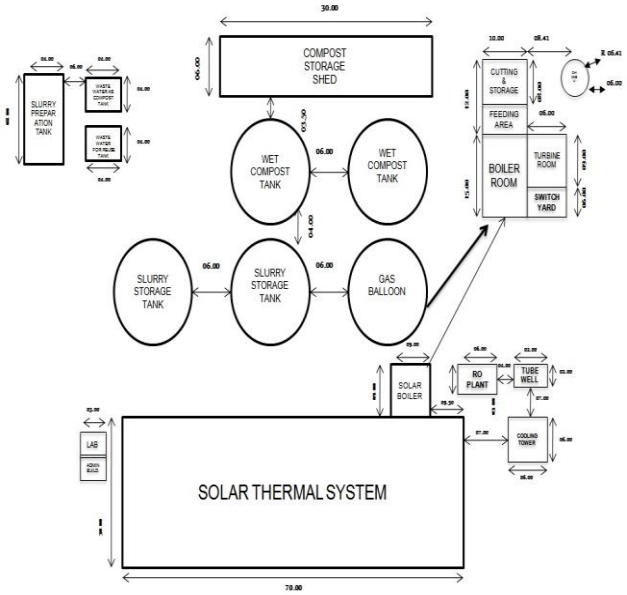

Fig.10: Schematic layout plan for three resource fuel input power plant

5. The power can be generated for 24hour by using available fuel at any given point of time.
6. The residue such as ash, compost can be locally used by farmers, who shall be supplying cow dung and bio mass i.e. Husk, Straw of Rice, Wheat, Mustard or Green Fodder. Hence, production of crops will increase.
7. The arrangement shall clear the local area of heaps of cow dung etc, which shall further be beneficial for the health of local population. (No flies' mosquitoes etc).
8. The public toilets (social welfare program) can be constructed in the premises of proposed station for bio gas production.
9. The project will generate local employment. The welfare scheme of Govt. of India such as MGNREGA will be logically implemented.
10. Reduction in green house gases (GHG) emission.
11. It will make Punjab, Haryana, U.P. and other Indian states independent of fossil fuels, to the larger extent.
12. Last but not least, by installing chiller plants for preservation and processing of milk at village level, the process of diversification of crops can be accelerated

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