Planning and Design for a Singapura Village in Karnataka for Self Energy Generation with Utilization of Sustainable Technologies

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ABSTRACT : *Energy is the main constraint for village development. Modern technologies of power generation doing by hand in hand with Mother Nature.. In past few year India has shown a significantly growth in utilization of renewable energy sources. Today the share of renewable energy sources is almost 12% in total electricity generation. According to Ministry of Power in India so far 1.15 thousands of villages still un-electrified [1].In this paper the potential of renewable energy sources (biomass) is estimated in a Singapura village in Karnataka, India. Based on a survey conducted in an Indian village named "Singapura" situated in district Mandya in Karnataka, the available biomass resources utilized. This paper provides a complete solution to meet energy demand of a village by renewable energy sources. This paper provides a better understanding of utilization of renewable resources in an isolated /off grid locations. Effective and efficient planning to utilization of biomass resources is main consideration for its maximum benefits. In present work detailed studies will be conducted for analyzing the problem of rural area (i.e. Case study of Singapura Village). The concept of Self Energy Generation with utilization of sustainable technologies. Seems to be the best solution for many problems of rural areas.*

***Keywords* -** *Biogas, Biomass, Solar Energy, Solar irrigation system*

I. INTRODUCTION

Energy is the main constraint for village development. Modern technologies of power generation doing by hand in hand with Mother Nature. But our vision Bio-energy village will not only give energy and feel independence to every village and every whole world. Increasing electricity demand, hike in fuel prices, environmental concerns are the main factors which motivates the use of renewable energy sources in India. In past few year India has shown a significantly growth in utilization of renewable energy sources. Today the share of renewable energy sources is almost 12% in total electricity generation. According to Ministry of Power in India so far 1.15 thousands of villages still unelectrified.

In India, Karnataka has highest production of maize, sugarcane and rice. In Karnataka burning of crop residues is a common approach to eliminate waste after harvesting (Fig.1). This practice emits trace gases like carbon dioxide, methane, carbon monoxide, nitrogen oxide, sulphur oxide and large amount of particulate matters, which adversely affect human health as well as the environment making the soil less fertile. Exploiting these resources will eliminate the requirement of electricity transfer to rural areas and improve the quality of life of the rural people by providing electricity for productive use in agriculture, ensuring the clean energy environment and also a less burden on conventional grid [2]. In order to provide feasible solution analysis has to be done on how the existing resources in a village could be utilized and they can be made useful for supplying the clean form of energy to the village itself and makes it sustained in its requirements [3]. This paper deals with a survey conducted in a village, "Singapura" of district Mandya in India. This village comprises of 40 household and the energy needs of the village based on the survey are noted down.

Fig. 1. Sugarcane crop residue

The following methodology for renewable sources of energy is proposed.

- ➢ Biomass based renewable energy system is proposed for meeting the electricity demand from households and other community loads which comprises the load demand of school, shops, community offices etc.
- ➢ Animal waste/crop residue is used for the production of biogas which serves as cooking gas.
- ➢ A solar water pumping system is proposed principally for village water supply and irrigation purpose.
- ➢ Solar street lights are used for village street lighting

II. PROBLEMS IN SINGAPURA VILLAGE

2.1. Available resources estimation

The site under examination is surveyed and various particulars of the village are demonstrated in a "Table 1."

Table .I. Village particulars

Village name	Singapura
Number of houses	40
occupation	Agriculture
Main crops	Rice,Sugercane, Vegetable,
Farmed area (hectare)	280
Average Connected load (kWh/d) Domestic Community	 220 20

The renewable sources of energy which are proposed to be used in meeting the energy demand of a village include biomass and solar.

Biomass can be produced from agro waste, mainly paddy and sugarcane and vegetables in the case of this village and can be utilized to generate electricity in a biomass plant. The average biomass available in area is 2 tons per day[4].

***2.2** utilization of resource*

There is no suitable method available for managing the crop residues in the village. Crop residues / biomass are simply burned in open field after harvesting and no utilization of available resources is done. The daily energy requirements like cooking are also met by LPG cylinders and fire wood.

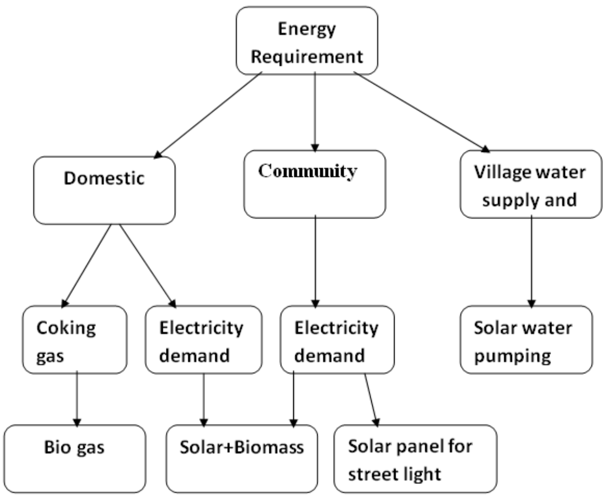
Discontinuous power supply because of difficulty in connecting them with grid and increase load on conventional
system is another problem for villagers so most of them are using diesel pump for irrigation purposes which are again inefficient and polluting.

So, for the place like in Karnataka where biomass and solar resources are abundantly available for electricity generation to meet the demand without any environmental hazard and making the village self-sustained in its energy requirement is the most suitable one.

III. PROPOSED PLANNING FOR ENERGY REQUIREMENT

"Fig.2" demonstrates the requirement of energy in a typical Indian village and proposed method to meet the energy demand.

Fig. 2. Energy requirement and proposed plan



for a village

3.1. The proposed solution for meeting the electricity demand

Hybrid (biomass + solar) renewable energy system(HRES) is proposed for meeting the electricity demand.HRES is designed based upon the certain important sensitivity variables to optimize the cost & size effectively[5]. Hence, before designing the model, certain parameters like solar irradiation, available biomass and load profile must be evaluated. HOMER software is used to determine the optimal sizing and operational strategy for a HRES. HOMERis a user friendly software tool developed by National Renewable Energy Laboratory (USA). It can be free downloaded from NREL website [6][7]. For carrying out the analysis the load profile taken from

Singapura village is used to simulate the whole operation for this system.

3.2. Village load assessment

In a village the demand for electricity is not as high as in urban areas.

The basic energy requirements in such areas can be classified as domestic, agricultural and community.

- In the domestic sector electricity is required to use appliances like television, compact fluorescent lamps, ceiling fans, refrigerator, cooler, heater etc.
- In irrigation for water pumping,
- The community load serves the community Centre, village community offices, shops, schools and medical Centre.

"Fig.3" and "Fig.4" shows hourly average domestic and community load profile respectively in proposed village.

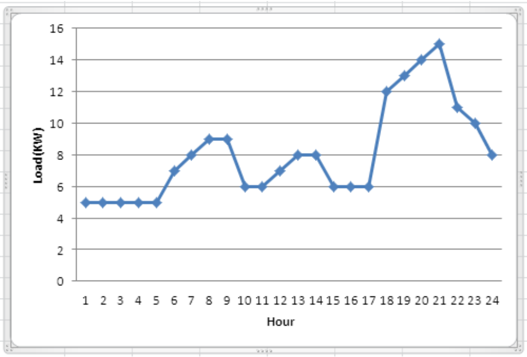


Fig.3. Hourly average domestic demand of proposed village

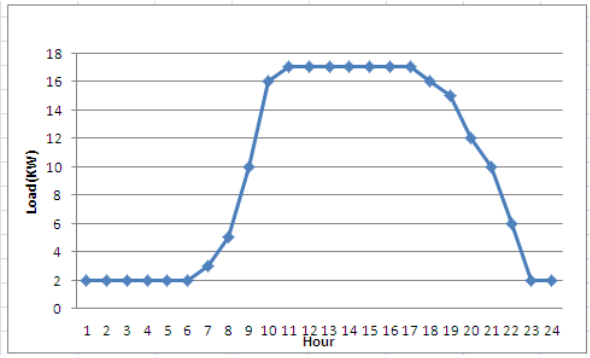


Fig.4. Hourly average community load profile of the village.

3.3. Biomass generator and biomass resource

The biomass gasification system is a technology which converts any kind of biomass energy with low heat value (such as waste from agriculture and forest and organic waste) into combustible gas and then feeds this gas to a generator for electricity generation. It is found that in village there is sufficient feedstock available for operating and installing a 40kW power plant [8]. The average biomass available in study area is 4 tons per day [9].

IV. PROPOSAL PLAN FOR OTHER DEMAND

4.1. Plan to meet cooking gas demand

The cooking gas demand can be met by producing biogas locally. Biogas is a clean and efficient fuel. Biogas is produced from Cattle Dung, Human Excreta and other organic matter in Biogas plant, through a process called 'Digestion'. Biogas contains 55% to 60% methane which is inflammable. The produced gas can be directly used for the cooking purpose which reduces the usage of firewood and its inefficient burning. For promoting the setting up of biogas plant the central sector scheme on National Biogas and Manure Management Programme (NBMMP) provides for central subsidy in fixed amounts, free maintenance warranty, financial support for repair of old-nonfunctional plants, training of users, financial support for institutions for cattle dung based power generation plants, etc.

The installation design of the bio-gas plant depends on the average population of cattle and the amount of dung available. The size of a plant, cattle dung available and estimated cost is shown in "Table 2."[10].

Table .II. Details of plant capacity and there cost.

Size of a plant	Quantity of cattle dung required daily	Number of cattle heads required	Estimated cost(Rs)
1 m^3	25 Kg	2-3	8000
2 m^3	50 Kg	4-5	12000
3 m^3	75 Kg	7-9	16000
4 m^3	100 Kg	10-12	20000
5 m^3	125 Kg	13-15	23000
6 m^3	150 Kg	17-20	30000
8 m^3	200 Kg	25-30	40000

As per the survey it is found that each household own about 3-4 cattle heads on an average resulting in a total of about 14 heads for four houses, so the family type biogas plant of 6 cubic meter size for four houses is proposed to meet the cooking gas demand which would be costing about Rs 30,000. So the total biogas plant proposed for villages are Ten.

4.2. Plan to meet irrigation load and water supply of a village

A solar water pumping system is proposed principally for village water supply and irrigation purpose. It consist of SPV modules of capacity 1800 Wp (75 Wp modules), 2 h.p. solar pump cables, switches and also available in 4 h.p.

Fig.5. A solar water pump installed in Hosahalli village in Karnataka

"Fig.5" shows a typical solar water pumping system installed in Karnataka. This kind of solar water pumping system is useful for small farmers and replacement of diesel operated water pump sets. SPV Pump set will have the capacity to give discharge of 1, 20,000 to 1, 40,000 liters on clear sunny day (approx.) subject to variation due to solar radiation and water table condition. This discharge will be suitable for irrigating 1.6-2 hectare of land. The main advantage of solar water pumping set are saving of electricity, diesel, long operating life, highly reliable and trouble-free performance, easy to operate and maintain and environmental friendly.

V. COST ANALYSIS

To meet electricity demand of village, a hybrid energy system is proposed whose optimized result is found with the help of HOMER software. The optimal configuration is 0.5kW PV array and 40kW biomass generator, with a levelized cost of energy (COE) of Rs 4/kWh and total net present cost (NPC) of Rs 57,36,028.

The cooking gas demand are met by effective use of manure available and a family type biogas plant of 6 cubic meter size for four houses is proposed which is costing to about 30000 Rs. So a single household will pay about 3840 to meet the cooking need instead of depending on LPG cylinders. It is found that at least 1 cylinder for 2 months which costs Rs 450 is needed by a family for cooking. So 240 cylinders would be needed for fulfilling the cooking demand of 40 families costing to about Rs 1,08,000 in a year and for a single household it would be Rs 2700 per year. Thus a payback period of about 9 months or a year is estimated.

For village water supply and irrigation a subsidized solar water pump of 2 h.p. is proposed which costs about 77,531 to farmers and is proved to be a very good solution for replacing the state electrical supply which are comparatively expensive and polluting. 20 solar streetlights which cost about Rs 1,79,340 are found to be sufficient for whole village. "Table 3" shows the total cost used in project to make a village self-sustainable.

Table .III. Cost details of proposed plan

Requirements .	Present System	Proposed system	Cost of the proposed plan
Electrical demand(domestic and community load)	Karnataka state electrical supply	Utilization of 100% renewable energy sources	Rs 57,36,028
cooking	Fire wood and LPG cylinders	Biogas production using Biogas plants	Rs 1,55,400
Irrigation and water supply	Karnataka state electrical supply	Utilization of solar water pumps	Rs 77,531(by considering state and central government subsidy)
Street lights	state electrical supply	Solar street light	Rs 1,79,340

VI. CONCLUSION

The objective to meet electricity demand of village can be achieved by making proper utilization of resources like biomass and solar. The two major problem of managing the residue left after harvesting and inconvenient electricity supply of villages could be well overcome by utilizing the existing resource of village and making itself sustainable in its energy requirements.

In this paper a hybrid system is proposed to integrate the abundantly available renewable resources which are a clean source of energy and are currently wasted due to lack of awareness. In this paper efforts are made to exploit biomass and solar resources in the region and suggest some of the cost effective and environment friendly ways to meet the demand. The cost analysis predict in spite of having huge capital and installation cost renewable energy sources prove to be more reliable and environmental friendly source to provide electricity in remote or off grid areas.

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