

Controller For Standalone Hybrid Renewable Power Generation

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Abstract— The project utilizes the resources available locally like sunlight, wind and biogas plant which can be installed with aids from government. A controller is designed to switch between generation sources with preference to renewable modes. When renewable energy is excess, the biogas is shut down and the power is used to pump water to a higher level, which can later be used for agriculture and micro hydro generation. In the hybrid system, energy has a higher reliability, can be cost effective and improve the quality of life in small town. At large scale and hybrid system will independently provide a stable power source and daily gas for small towns. Hybrid power system that aims to increase the system efficiency and increase use of renewable energy based hybrid power system. In order to meet sustained load demands during varying natural conditions, different renewable energy sources need to be integrated with each other like solar, wind, waste of energy municipal waste/ liquid waste, small hydro.

Index Terms— Dump load, dump power control, Fuzzy Logic Controller, low cost, standalone hybrid power generation.

I. INTRODUCTION

Hybrid systems are usually a combination of photovoltaic with wind turbines and/or generators running on diesel or bio fuels/biogas is also used. Power generated by the PV array during the day is stored in the utilized through an energy manager, which controls the complete system. Diesel generators are expensive to run, and may also require frequent maintenance support. A judicious mix of solar and other renewable technologies, coupled with a biogas generator, 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 Cutting edge technologies based on latest research to integrate different power sources in the most ideal way.

The energy consumption increasing day by day, supply is depleting resulting in inflation and energy shortage. Limited amount of conventional energy sources remaining and very polluting. Thus we are forced to look for unconventional energy sources. Non-conventional energy sources are

unlimited and free, nonpolluting. Since this work is preceding one step ahead and we are try to building a hybrid system with use of non conventional energy source. Among of these major applications one of them is solar photovoltaic system, wind power generation and biogas generation. These approaches are appropriate in order to cope high power availability needs: by increasing the photovoltaic size or by using additional energy source: hybrid power system In this chapter, hybrid connected solar photovoltaic systems, wind power generation and bio generation are explained.

II STANDALONE HYBRID SYSTEM

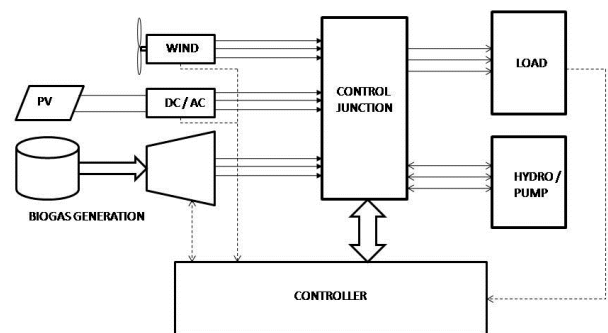


Figure:1 Overall block diagram of the project

The proposed combination consists of a wind solar renewable combination along with a complementary biogas power generator which acts as the supplement. The capability of the electric generation hybrid systems is to satisfy the power demand on the atmospheric conditions. Such conditions will define different operation modes of the system. Basically these operation modes are determined by the energy balance between the total generation and the total demand. A comprehensive controller is essential to efficiently manage the operation of the generation subsystems accordingly. For the design of such a controller, in priority the preference of main generation would be given to renewable resources while the biogas generator would play a complementary role.

The design decision of the renewable combination can be decided by the geographical area of the location in demand.

The important requirements of the standalone hybrid system are the availability of renewable resources. Then the proportion by which the renewable sources are combined plays a vital role. So a detailed analysis is required on the location about the availability of the resources all through a year. Then the combination has to be formulated for the efficient investment and operation of the system. Selection of the type of renewable generation is also vital.

III. POWER FLOW ANALYSIS

The power flow analysis of the system can be analysed in three different modes.

Mode 1:

It corresponds to the periods of sufficient renewable power generation to satisfy the total demand. The controller tracks the total demand and utilizes the available renewable resources to feed the demand.

When the power generated is much higher than the load the dump load is activated and the available excessive renewable energy is used to pump water to higher altitudes in view as to use it for agriculture and micro hybrid power generation.

If the demand is higher than the generation by combined renewable resources then the operation is as in the mode 2

Mode 2:

Whenever the demand and generation come in par with each other the controller switches on the biogas generator and synchronizes it to the renewable hybrid generation as a spinning reserve. So the occasional deficit power is taken care by the spinning biogas reserve and the demand is met. Now the dump load is completely isolated from the system to avoid consumption of power from biogas. This is important as to maintain reserve biogas in the storage tank to feed the demand.

Mode 3:

At times the renewable resources become totally unavailable. During this time, the biogas generator plant generates to its full capacity and feeds the total demand. However the operation of the system in made has a time restriction as the supply of biogas is not surplus. It relies on the storage capacity and the generation capacity of the biogas plant. The waste and the input materials for the biogas generating plant may be limited. Nevertheless the situation is highly unlikely if the system modules are sized to reduce the blackout situation to a minimum.

To summarize the controller acts as the supervisor and is responsible for switching from one operation mode to another depending on the atmospheric conditions and the load demand. It is in-charge of setting the reference values of the generation modules. The usage of batteries as the storage

element as purposely avoided as it need to be replaced at any regular interval depending on the type of battery.

IV. CONTROLLER

The controller does the analyses of the change in load and accordingly changes the mode of operation of the system. The input parameters to the controller are

1. Track of load
2. Wind availability
3. Solar radiation available

The importance is given to the renewable modes of generation. The demand is fed in four threshold levels. Based on the demand the generation facility is chosen. When the renewable resources are available and sufficient to meet the demand, Biogas power generator is shut down. When the renewable modes are not sufficient, the biogas power generator is switched on and synchronized with the available power generation to meet the demand.

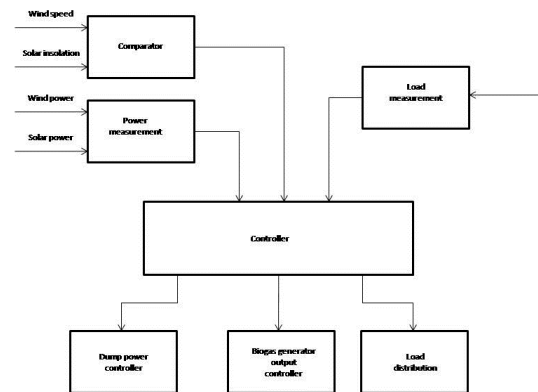


Figure 2: Block diagram of the controller

The performance of the standalone hybrid distributed power generation has been excellent throughout the globe. In modern days many such systems are installed in various countries to compete in reducing the carbon footprint made by any country. Developed countries have already switched over to renewable systems in many patterns. But developing country like India is still deficit of power. So even though the harvesting of renewable energy has increased multifold the demand is yet to be reached.

FUZZY LOGIC

The word fuzzy logic suggests inaccuracy and imprecision. Fuzzy logic is an approach in computer science that mimics the way human brain thinks and solves problems. The idea of fuzzy logic is to approximate human decision making using natural language terms instead of quantitative terms. It is formally defined as a form of knowledge representation suitable for notions that cannot be defined precisely, but which depend upon their contexts. It enables computerized devices to

reason more like humans. Fuzzy logic technology has created a paradigm shift evident through many scientific and industrial applications.

In this project fuzzy logic controller is used to control the output of the power system in analyzing and identifying the generation and load equations. The input to the fuzzy logic controller is designed after a detailed study of the geographical location where the power system is to be installed. The physical parameters like solar insolation and wind speed are given as input along with the electrical parameter which is the predicted load demand at any instant.

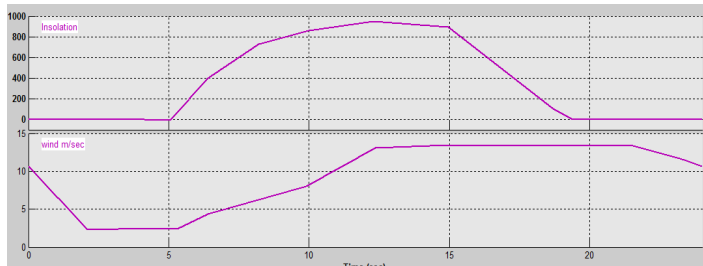


Figure 3. Input of physical parameters.

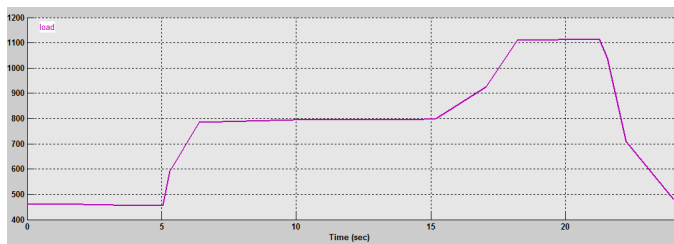


Figure 4. Input of electrical parameter.

The controller is fed with predetermined set of rules which in this case counts to 125.

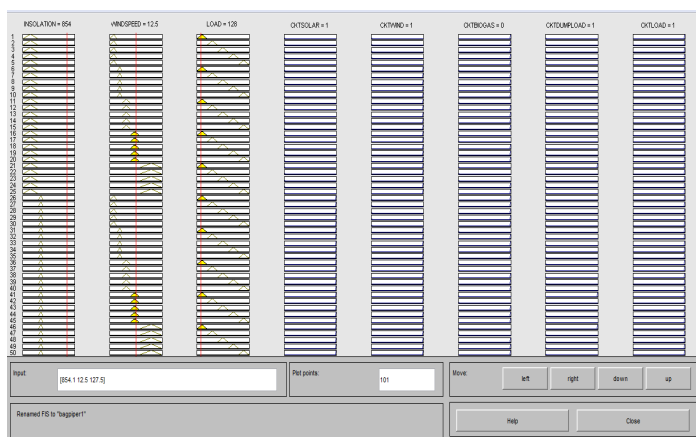


Figure 5 Rules for the fuzzy controller

These rules guide the fuzzy logic controller in switching between different generating modes. It covers output data for all values in the input range.

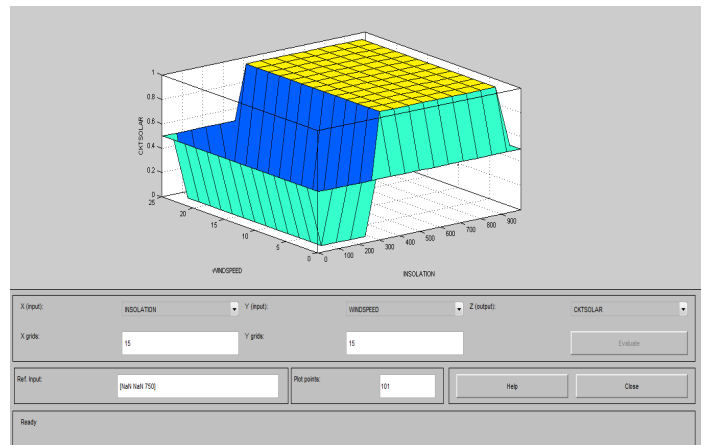


Figure 6. Surface viewer for the rules.

Different combinations

The different combinations of the standalone hybrid system varies quite vastly. But it is usual to have a available combination of renewable resource along with a conventional system running as a complementary resource.

Proposed combination

The proposed combination consists of a wind solar renewable combination along with a complementary biogas power generator which acts as the supplement. Since the village is expected to have cattle biowaste along with human, biogas is easily produced. In long run the cost of running gets very cheap as the fuel is almost free and leads only to a cleaner environment.

Possible benefits

The benefits of the proposed combination can be listed as below:

Availability of reliable power

Cheap power

Development of the community through technological advance

Provides employment opportunity

Generates considerable revenue.

V. RESULTS AND DISCUSSIONS

The results of the system has been discussed in four stages as

- 1) 25% of load
- 2) 50% of load
- 3) Full load
- 4) Minimum load.

25% Load:

When 25% of the load is present, the controller feeds the demand with the available renewable energy or switches over for the deficit power from the bio-gas generator. During this time the dump load is off.

50% Load

When 50% of the demand prevails, a slight decrease in the renewable system may affect the reliability of the power system. Due to this, the bio-gas generator is turned on and synchronized with the system. If the renewable source is sufficient to supply the demand. During this time biogas generator remains as a spinning reserve. If there is any decrease in the renewable energy, biogas generator feeds the power and maintains the stability of the system.

The dump load is not in operation during this mode of operation.

The system utilizes renewable energy and the biogas generation to feed the demand.

Full load:

At full load condition the renewable and the biogas generation is combined to meet the demand. Even if the renewable energy is fully available, the power from the biogas generation is used to feed the demand.

The biogas generation is in synchronism with the system and the load demand is met. During this time the dump power is not operated. So the power generated is fully utilized to meet the demand. Since the installation capacity is lesser than the full load demand the biogas reserve is used during full load operation to supply the deficit power. This conserves the use of biogas.

Minimum load:

When the demand is less than 25% of the total load, and during times when the renewable generation is well sufficient to meet the load demand, to utilize the excess power generated a dump load in the form of a hydro pump is used to pump water to a higher altitude or irrigation pumps are operated during this time. The biogas generation is not operating and only the renewable energy is used for operating the dump power.

The load sharing between the different power generation is shown from the graph. When the total load is 1.5 MW the contributions from solar, wind and biogas generation are 300, 350 and 850 respectively.

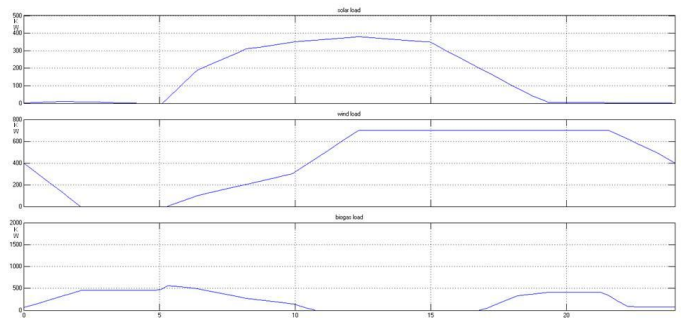


Figure 6. Output of the system

VI. CONCLUSION

Since the need for energy is increasing, renewable energy emerges attractive due to its clean nature and to reduce the carbon footprint in earth. Since the renewable is combined with biogas generation system, the waste management is carried out efficiently. The hybrid system of wind/solar generation and biogas generator keep the stable output electricity by simulations. The dump power utilization by using a micro hydro is experimented and batteries are eliminated in the system. Depending upon the variation in discharge and availability of other resources and future increase in demand, the hybrid energy system as indicated above may be able to fulfill the demand of area in the integrating manner. The local people will be employed to take off the operation and maintenance of the power system as well as to manage the collection of revenues from each household, which may be used for maintaining the sustainability of the system.

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