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P. Sridhar Acharya & P. S. Aithal

Srinivas Institute of Management Studies, Pandeshwar, Mangalore – 575 001, India
E-Mail: sridharaacharya@gmail.com

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Increasing the Efficiency in Renewable Energy- Challenges and Solutions for Rural India

P. Sridhar Acharya & P. S. Aithal

Srinivas Institute of Management Studies, Pandeshwar, Mangalore – 575 001, India
E-Mail: sridharaacharya@gmail.com

ABSTRACT

It is very much true that people living in most of the rural areas depend on renewable energy resources for their daily domestic requirements. They either get an interrupted power supply from the traditional commercial electric supply or in some cases where the people living in a remote location may not get the traditional supply due to the distance. The people in the rural area already started using renewable energy resources for their daily needs. But it is seen that most of the rural area are potential to use many forms of renewable energy resources. There is a major requirement in combining more than one form of such energy to fulfill the needs. This paper explains the different methods of production of energy using the renewable resource in the rural area and a model to combine them to use the energy efficiently. This model suggests the controller to be designed which will use the energy produced from renewable energy efficiently. This controller has a responsibility to avoid the energy from the traditional method as long as there is a supply of energy from renewable resources. The controller uses the traditional energy only when there is no alternative energy supply from renewable energy.

Keywords: Renewable energy, Charge controller, Traditional energy, Multiple renewable energy.

1. INTRODUCTION

The traditional electrical system is not in a position to fulfill the requirements of the public [1]. More over the system is concentrating on the cities and industries in providing the electrical energy. These traditional methods include electricity from water- hydro electricity, electricity from coal-thermal electricity and electricity from uranium-atomic energy [2]. The people living in the rural area are not able to get the energy from the traditional method due to distribution problems or the cost of distribution to the rural area may be very high in such a way that the concerned department may find difficult in recovering the investment. Due to this almost 400 million people are still not connected to the traditional grid [3]. The agriculturists depend on electricity for their agricultural activities. This results in improper cultivation due to the lack of water. Also, the agriculturists cannot adopt the latest technology in agricultural sector due to the improper availability of electrical energy from the traditional system. The better solution is to go in search of renewable energy resource which is suitable for the current area.

Here the agriculturists should discuss with the experts in adopting the energy from renewable resources as per the requirements [4]. There are chances of adopting energy resource for the agricultural land using multiple renewable energy resources. The most common energy resources are the Sun, wind and water. To generate hydro electricity the area should have more rain fall. Presently the use of solar energy is getting more and more popular in India [5]. The power system which combines the solar energy and conventional energy system and the load is well managed by combining the solar and conventional energy system [6]. The major drawbacks are :

1. This system does not combine multiple renewable energy systems.
2. This system does not prioritize the renewable energy to the conventional energy

The first one is very clear that the present system cannot combine more than one renewable energy system along with the conventional energy system. So it is very much necessary to design a new model which could take as many energy sources as possible.

The second point is a deficiency in the present solar energy system which is available in the market. The problem is the present system supplies the energy to the load from the storage device. The storage device will be recharged from either conventional energy system or solar energy system. Suppose if the energy stored in the battery is used when there is no availability of solar energy, then the system recharges the battery from the conventional energy source. The solar energy which will be available later will not be used to recharge the battery as the charge stored in the battery is full by the conventional method [7]. This does not utilize the solar energy efficiently. Thus it is very important to design a controller which will combine all sorts of renewable energy and uses them at most efficient way.

2. OBJECTIVE

The objective of this paper is to propose a model which combines the electrical energy generated from multiple renewable energy resources and avoid the usage of the traditional energy as long as the renewable energy is available. This model is designed in such a way that the complete usage of energy generated from renewable resources saving the traditional energy system to the maximum extent.

3. METHODOLOGY

There are two different models developed. First one works on the principle of time management and the second one is fully automatic which takes the self-decision based on the various inputs. The diagrammatic representation of the first model as given in figure 1.

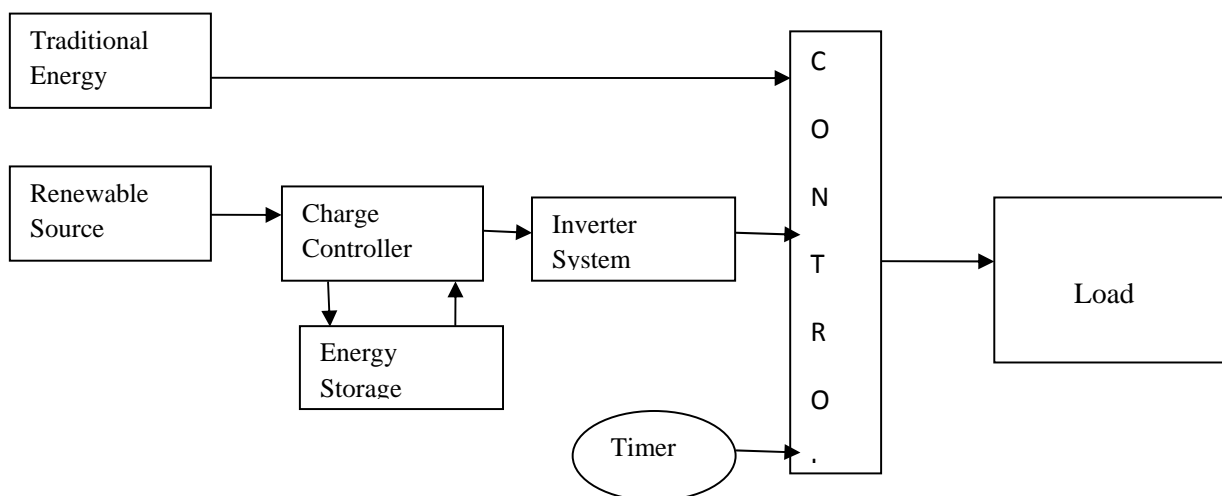


Figure 1: Model using the renewable energy and traditional energy controlled by the controller with the help of a timer

According to the above model, the controller is utilizing the energy from the renewable source. The load is entirely taken by the renewable source. If the renewable energy is not sufficient to fulfill the load requirement then the energy stored in the battery will be used. The battery will be charged when the load requirement is less than the production from the renewable energy resource. Here the traditional energy is only used if there is no energy either from a renewable resource or from the storage location i.e., the battery is available. The change over from the renewable energy resource to traditional energy resource is managed by a timer circuit which should be programmed. The factors for the timing program depend on the amount of energy produced by the renewable resource per day and the amount of energy required by the load for a day. The small changes in the energy production by the renewable source cannot be considered as the change factor from renewable to traditional is the timer circuit which is programmed. The timing program has to change from season to season.

There is another model which is shown in figure 2 which functions totally automatic by taking various reference voltages. Here the timer circuit is not required. The model as shown in figure 2 is designed in such a way that it is totally self controlled and it doesn't depend on the timer circuit. The model senses the energy generated from the renewable energy resource and supplies the same to the load. If the load is less than the energy production from the renewable resource then the energy gets stored in the battery. If the energy required to the load is more than the production the difference will be taken from the battery. The controller charges the battery using the renewable energy only as long as the energy in stored in the battery reduces to V_{min} which is considered to be critical level. This condition makes the battery to charge using the traditional electric supply to reach V_{ref} Once the V_{ref} is reached then the controller stops charging the battery from the traditional energy supply. Now onwards the battery will be charged to the maximum voltage V_{max} using renewable energy source. The performance of the controller is explained in Table 1.

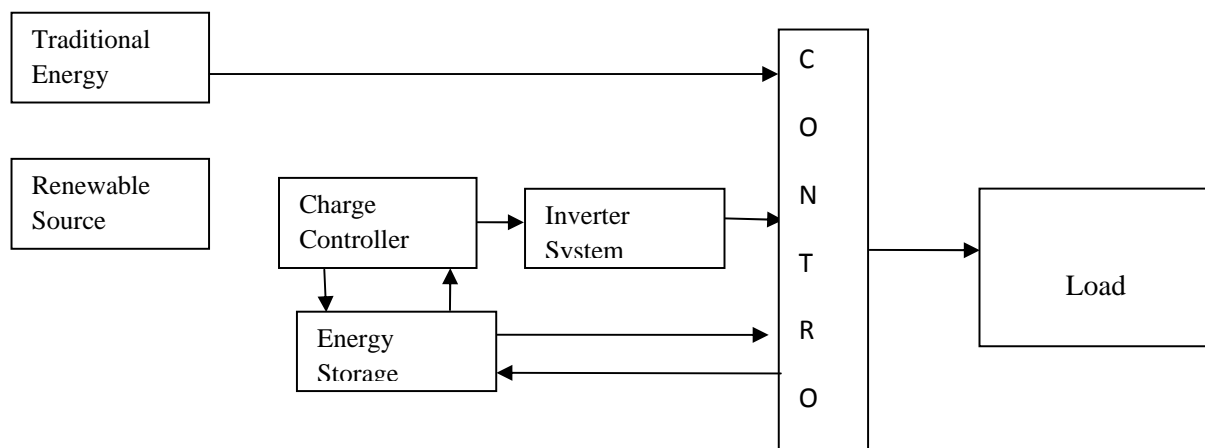


Figure 2 : Model using the renewable energy and traditional energy controlled by the controller by referring battery voltage

Table 1: Proposed performance of the control unit when multiple input energy from renewable energy resource is given.

| Sl. No | Status | Condition | Action on the load |
|--------|--|---|--|
| 1. | Voltage in Energy storage is V_{max} | Energy supply from the renewable source is more than load requirement | Load is given energy from the renewable resource |
| 2. | Voltage in Energy storage is V_{max} | Energy supply from the renewable source is less than load requirement | Load is given energy from both storage and renewable resource |
| 3. | Voltage in Energy storage is $< V_{max}$ and $> V_{min}$ | Energy supply from the renewable source is more than load requirement | Load is given energy from the renewable resource and the storage is storing the energy |
| 4. | Voltage in Energy storage is $< V_{max}$ and $< V_{min}$ | Energy supply from the renewable source is more than load requirement | Load is given energy from the renewable resource and the storage is storing the energy |
| 5. | Voltage in Energy storage is $< V_{max}$ and $< V_{min}$ | Energy supply from the renewable source is zero | Load is given energy from traditional energy system |

4. ANALYSIS

From the above model, it is very clear that the complete energy produced from the renewable energy system is utilized for the load and excess energy will be stored in the energy storage. The controller plays an important role in selecting the input energy for the load. Here the controller takes the energy

from multiple renewable energy input. The smart decision taken by the controller helps in selecting energy from either a single input source or multiple input sources. Here the controller does so as per the load requirement. The controller does not select the energy from the conventional energy system which is also one of the energy sources at the input in the normal conditions. The conventional energy is considered for the load as well as for the backup charging only when the input voltage from any renewable energy resource falls below the critical energy i.e., V_{\min} . Thus the multiple renewable energies from the input is utilized in an optimum level.

4.1 Advantages

The controller has a major advantage of utilization of energy from renewable resources. The use of traditional conventional energy is saved. The energy from the conventional source is utilized only in case of emergency.

4.2 Benefits

Using this type of controller provides integration of renewable energy from multiple resources. This system provides an opportunity to implement multiple renewable energy resources.

4.3 Constraints

The design of controller needs the study of the location before implementation. This puts the limitation on the mass production of the controller. This constraint results in increased cost of production of the controller.

4.4 Drawbacks

Implementation of the system needs the initial expenditure which is marginally costlier. This may not entertain the rural agricultures to adopt the technology. This technology after adoption needs trained people in the site to observe the performance of the system. This system may need few years to recover the cost invested. The regular maintenance of backup storage and inverter system is another drawback.

5. CONCLUSION

The above model is used to utilize the renewable energy to the hundred percent. The amount of energy produced from renewable energy may vary from season to season. But the utilization of the renewable energy will be maintained hundred percent. The traditional energy is used only if there is an excess requirement. The first model requires a timer to be set for auto on and off. This timer setup changes from season to season. The second model since it doesn't depend upon the timer circuit is functioning fully automatic and it automatically changes its controller because the controller is working on the voltage level of the Energy Storage.

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