Single Axis Sun Tracking System and Solar Power Back-up System

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Abstract - As a solution to the studded power outages in Sri Lanka and considering the possibility of earning a comparatively higher solar energy yield, this system is proposed in this paper. 'Solar tracker system', 'charging control unit', 'off - grid inverter' are the prioritized systems of this project. There are other sections such as the 'Changeover unit' and the 'Monitoring system' as well. A low-cost, high-efficient solar inverter with a solar tracker and power backup is also a part of the proposal here. The solar tracker system would track the direction of more sunlight falling with the help of the LDRs present and allow the solar panels to move East or West in order to receive efficient sunlight for power generation.

Keywords: Solar tracker, off-grid inverter, charging control unit, power back-up

I. INTRODUCTION

Solar energy has gained more attention over the last decade and Sri Lankan domestic consumers are showing an interest in installing solar power systems in their households. But, the cost of solar systems cannot be afforded by the majority of domestic consumers. As a solution, this project proposes a low-cost and efficient solar power system for both domestic and industrial consumers. The efficiency of the system is enhanced by the solar tracker which helps to harvest the optimal amount of power from the solar energy. A few problems were identified in order to put forward this particular project into action. The pattern of the rise and setting of the sun differs due to the seasonal changes in Sri Lanka. Therefore, a specifically coded sun tracking method would not be suitable, as the weather and the climatic changes at present are quite unpredictable. When the solar panels are fitted to the rooftop or railing just as usual, then it is not very accurate that a good amount of solar energy from the panels would be received [1] . Also in Sri Lanka, the solar panels are mounted in a specific direction (towards the south) at an angle of 9 degree or 10 degrees, as Sri Lanka is close to the equator and the possibility of receiving efficient and maximum sunlight to fall on the surface of the solar panel(s). According to the Sri Lankan context, hybrid and on-grid solar power systems are more popular due to consumers being able to maintain a continuous energy supply with the help of the national grid [2]

The aim of the project is to bring power to the life of anyone and everyone. The hybrid inverter which is the only possible way of having power when there is a power - cut. But the hybrid inverter is not affordable for everyone. For example, it is very dangerous for anyone who has an aquarium to be unable to maintain, as the fish needs oxygen supply continuously, which uses power. So, it is very important for people like them to have continuous power supply. So, in situations like these this project will be very convenient and will be handy. So, this complete system of solar power generation and power back - up is going to be compromising and very useful.

II. SYSTEM MODEL

Fig.1 shows a simple block diagram of the proposed system where the sun tracker is built on a small solar panel. The feedback of the tracker is sent to the motor control unit and the required angular rotation can be estimated accordingly. To avoid mechanical interruptions, solar tracker is built on a separate small-scale panel rather than connecting it directly to the main solar panel.

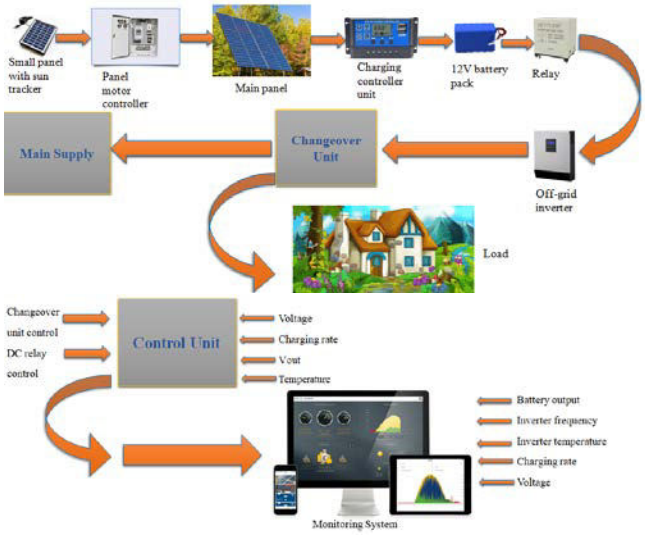

Fig. 1 System architecture for the proposed solar system

The charging controlling unit is fed specified voltage and the charging rate to the control unit. Then the relay with suitable rating is connected to the battery which is simply operated by the charging controller unit. When the relay is switched on,

generated power is coupled with the inverter, and then to the changeover unit which is again controlled by the charging controller unit. The details on charging rate, temperature, and output voltage reach the main controller unit, by switching on and off the 12V relay that is in the control unit. And the monitoring system would be helpful in monitoring the temperature, charging rate, and checking on the power, battery output, off - grid inverter, and voltage. This would be done by a remote monitoring system, and here the monitoring system would also be in connection with the control unit. The system would have the minimum power point, tracking charging and a standby power solution. Individual blocks of the system are detailed out in the following subsections.

A. Solar Tracker

The main solar panel(s) are usually mounted and fixed to the rooftop or on a railing, in order to receive direct sunlight. Here, one side of the solar panels is fixed onto the railing or the rooftop and makes it possible to tilt over the single axis up and down at an angle of 30^{o}. The panels will be tiltable so that it would be possible to position itself to the peak value when the solar intensity is low. The small panel of size (2x2) inches, would be capable of movement but one side of it would be fixed. It is going to be possible to produce a 1.5V with the help of this small panel, which would move in two directions but in a single direction with respect to the angle of 30^{o}. It would be possible with a motor that would change the direction of the panel when there is low sunlight in contact with the small panel. The motor movement would then be stopped, when the signal is received for the specified position where the panel gets the maximum sunlight for the generation of optimum solar energy. The small solar panel would pass the signal to the motor control unit, which would then be passed to the bigger panel. The small panel sends a pulse or signal to the motor control unit, which would then be directed to the bigger panel for the movement of the bigger panel to be accordingly. The specific direction in which the big panel has to move and the exact position it would be located, will be provided to the big panel through the motor control unit from the small panel to which the solar tracker is connected.

B. Charging Control Unit

The production of constant voltage would be achieved using an adjustable voltage regulator (LM317). The diode is used to protect LM317. The output voltage can be adjusted with the help of this LM317. Overvoltage cut – off facilities. The battery of 12V and 1.3A per hour is also a part of the charging – controller unit. The capacity of the charging controller unit can feedback the drop signal coming to it and give it back. If the battery is thirteen volts, a protection circuit is included inside the IC to prevent it from overcharging. Here no matter how high the input voltage is, the output voltage will not be higher than the pre-specified value in the system.

C. Off Grid Inverter

The 555 timer IC in an off-grid inverter circuit is used to drive a D-type flip-flop produced using a CMOS type 4013 IC. The timer IC produces perfect complementary square-wave signals [3]. Darlington power transistors are used to arrive at the necessary output current. MJ3001s are cheap and readily available. The square wave coming into the inverter is converted into a modified sine wave. After applying a DC voltage to the transformer, the next step is to oscillate. The signal from that oscillator is a very small signal. But when the system converts this signal into energy, it will amplify. This happens in the Driver unit. Then the output is taken according to the amount that has to be output. From the output, it is fed into the transformer directly. The filters are added to make corrections in the waveforms [3].

D. Change Over Unit

This unit has one-time and two on/off functions. Also, all the following units are connected to this controlling system. If there is Voltage, charging rate, Temperature, and V out. The purpose of this unit is to isolate the circuit from the grid. It is a system that is in the middle of the load and the off – grid inverter (system) [4].

E. Monitoring System

With the help of the monitoring system, able to track the functions that were proposed. The software will be developed to display the line voltage, battery charge, power generation, and status of the inverter [3]. The monitoring system can be put in action by using a Wi – Fi module and also it can be done by merging it with the IOT [5].

III RESULTS AND DISCUSSION

The ‘Solar tracker’, ‘Charging control unit’ and ‘Off - grid inverter’ were designed in the Proteus 3.0 simulation software and tested. The output of the solar tracker system was checked by adjusting the resistance of the LDR and changing the values of the variable resistors as inputs. The prototypes made were tested. The solar tracker system was tested by giving an input of 12V with the help of the power generator and the DC motor that was a part of the system rotated. The charging control unit was also tested, in the same way as the solar tracker system. Power supply was given for the input of charging control unit with the help of the power generator in the laboratory. The observation was made by connecting a bulb and the bulb lit brightly.

IV. CONCLUSION

The uniqueness of the project is to make it possible for everyone to afford power generation and a power back - up. In future, it could be expanded by introducing it to large-scale companies and industries that have more needs and necessities. Increasing the number of batteries, and or increasing the storage power of the battery will give us more room for storing more energy. As mentioned in section III

'Results and Discussion', the solar tracker system and the charging control unit were tested. But, the off – grid inverter was not tested as the required component for it was unavailable in Proteus. So, that can be overcome by trying to redesign the off – grid inverter system in another simulation software and then testing it. There are many systems that have the solar tracking method, inverter system, control units, separately. But this would be the very first time that all the unique and important systems are combined together to give amazing results for efficient power generation and power back-up system during power failures.

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