Hybrid energy harvesting system using IOT

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ABSTRACT:
Global warming, environmental pollution and power production costs are the major issues that the world is facing and many research work is done in the above areas to reduce the adverse effects arises due to fore mentioned issues. In particular, many research has been carried in power generation without CO2 emission and polluting the environment. This can be achieved by using renewable sources for electrical energy production in optimized manner. This paper presents a hybrid energy harvesting by combining thermoelectric Generators (TEG) along with solar energy to develop electrical energy. The proposed framework has been intended to harvest energy to an extent that it can gather both solar energy and the heating effect in the panel at the same time. The solar radiations are made to fall on the PV panel, which is productive enough to collect the light radiations falling on it and convert into electrical energy. Meanwhile, these radiations cause warming up of the PV panel, prompting the decrease in its effectiveness of production. Hence in order to increase the efficiency of the system energy harvesting, this heat production is utilized using TEG. The thermoelectric generators are used which retain this warmth and create an electrical energy in the form of DC based on seebeck effect. This project utilize a PV panel and a thermoelectric generator to incorporate both light and warmth for harvesting electrical energy. This output energy is needed to regulate with the help of dc-dc converter. The contribution of energy from PV panel and thermoelectric generator are given to the buck boost converter. The output of the converter is stored in the battery which can be used for direct dc load or through inverter for ac load. This project also implements internet of things (IOT) technology to monitor and manage the electric energy harvested through this technology from anywhere.

1.INTRODUCTION
Recently the energy consumption is in the range of 10 terawatts per year, and in 2050 it may reach about 40 terawatts. This energy requirement using conventional source like fossil fuel, nuclear etc., will produce CO2 emission and pollutes the environment [1]. In order to overcome this problem renewable energy sources are being used widely for the production of non CO2 electrical energy. The simplest approach to control CO2 by mid-century is one in which photovoltaics (PV) and other renewables are used for electricity generation, for transportation usage of hydrogen fuel, and fossil fuels can be used for residential and industrial heating [2]. Thus, solar energy conversion will play a vital role in satisfying the world energy demand in future [3]. Due to wide research happened in solar cells, extraction of maximum energy from PV panel using multi junction cells are used nowadays. Even while using advanced technology in PV cells, a huge amount of the solar irradiance is not converted into electricity and is dissipated as heat. Hence to increase the system efficiency in a better manner harvesting of this heat produced in PV panel can be used which is considere as complementary “green” technology, namely, thermoelectricity [4]. According to this methodology, a thermoelectric (TE) generator (TEG) can be attached to the back side of the PV panel to harvest the e heat for generation of additional electricity, resulting from the Seebeck effect (the thermoelectric effect [5-11]). The Internet of Things is a constantly-evolving area of research, with many new applications and ideas being generated almost daily. From intelligent farming to smart devices in our homes, the IoT has affected almost every industry in our modern world [12]. The IoT has been evolving fastly over the last few years. Billions of devices and systems are already connected, with more being added every day. The IoT communicates with...
sensor data and not with words which makes it much reliable. This makes it possible to continuously monitor and control devices, systems, processes and infrastructure. There are already countless practical applications, from smart homes to smart lighting to smart roads. Interconnected production has become a major trend in the industrial sector, too [17] [18]. Hence, interconnection of solar and TEG will make the energy production effectively and efficiently by including IoT for proper regulating and management of electrical energy.

2. EXISTING SYSTEM
Nowadays solar energy is becoming popular and consumed commercially in huge proportion. As it is natural source of energy the production cost of power using solar is very much less compared to other conventional sources. The concept of TEG is being used in panel whose temperature difference can be converted as electrical energy which is used in miniscule range for various loads. Mainly, in the existing system, the solar panel and the thermal power plants are separately handled. This results in a large amount of losses due to energy conversion from solar energy to electrical energy. The cost for power generation by this method is huge. The load imbalance which occur in this system cannot be managed very easily. Fig 1 shows the existing system of energy conversion using solar energy where each energy conversion system works independently and not economical.

![Figure 1 Block diagram of the Existing system](image)

3. PROPOSED SYSTEM
In proposed system as per figure 2, the energy is harvested using solar and TEG which similar to the existing system, but the harvested energy is hybridized which can be properly regulated and managed through microcontroller and IoT mechanism. The produced energy by hybrid technique are used for DC load through battery and Buck boost converter. The same energy is converted to ac through inverter and it is used for AC load. These two operations are exactly same as existing system, but in proposed system the output of PV and TEG is hybridized. Therefore, the solar panel output and thermoelectric generator output is given to the buck-boost converter which provides a regulated output voltage to match the battery charging voltage. Power supply for the DC grid will be taken from the battery terminals directly. The power supply for AC grid will be taken from the battery terminals via inverter. Apart from hybrid technique, microcontroller and Arduino nano is used to measure the power generation by solar and thermoelectric generator for proper management through IoT. The same will be monitored on the LCD.
In the proposed system, the load balancing problem due to individual source supply has been overcome due to hybrid technology i.e., the integration of heat and light concept is introduced. The major advantage of the proposed system is that the system consist of various protections like reverse current protection. The bypass switch helps to decide whether the battery or the load is to be connected.

4. HARDWARE SETUP
The overall hardware setup can be divided into two units namely, power generation unit and power regulating and management unit. Figure 3 shows the power generation unit which comprises of solar panel and thermo electric generator unit which poses of temperature sensors and conversion unit.

Figure 4 represents the hardware setup of power regulating and management unit. The hardware setup consists of Solar Panel, Thermoelectric Generator, Buck Boost Converter, Digital Temperature Sensor, 5V DC Regulator, ATMEGA32A Microcontroller, ESP8266 Wi-Fi Module, LM358, 16X2 LCD as the major components. This unit gets the input from the power generation unit and converts into dc or ac voltage based upon the requirement of load with the help of buck boost converter and inverter.
Figure 4 Power regulating and Management hardware setup

a. BUCK BOOST CONVERTER

Figure 5 and 6 shows the hardware part of buck boost converter and circuit diagram of it. The working operation of the DC to DC converter is the inductor in the input resistance has the unexpected variation in the input current. If the switch is ON then the inductor feed the energy from the input and it stores the energy of magnetic energy. If the switch is closed it discharges the energy. The output circuit of the capacitor is assumed as high sufficient than the time constant of an RC circuit is high on the output stage. The huge time constant is compared with the switching period and make sure that the steady state is a constant output voltage \( V_o(t) = V_o(\text{constant}) \) and present at the load terminal.

Figure 5. BUCK BOOST CONVERTER
b. DIGITAL TEMPERATURE SENSOR:
The DS18B20 digital thermometer provides 9-bit to 12-bit Celsius Temperature measurements and has an alarm function with non-volatile user programmable upper and lower trigger points. The DS18B20 communicates over a 1-Wire bus that by definition requires only one data line for Communication with a central microprocessor. It can derive power directly from the data line, eliminating the need for an external power supply.

They work great with any microcontroller using a single digital pin, and you can even connect multiple ones to the same pin, each one has a unique 64-Bit ID burned in at the factory to differentiate them. When using with Microcontroller put a 4.7k resistor to sensing pin, which is required as a pull-up from the DATA to VCC line.

5. HARDWARE RESULTS

Figure 8 represents the temperature of the solar panel which works according to seebeck principle. The PV panel when exposed certain radiance the temperature difference on the panel is measured which is as indicated.
Figure 9 indicates the voltage output from the solar panel which is 15 volts and Figure 10 indicates the output voltage of 9V from TEG due to the temperature difference as mentioned in Figure 5.

Figure 9  Output voltage due to PV panel

Figure 10 Output Voltage due to TEG

Figure 11 shows the working of complete circuit board which consists of two section namely, buck boost converter whose output is connected to LED and the output of buck boost converter which is in the form of dc is converted to ac with the help of inverter section and that output is given to bulb.

Figure 11 Output of ac and dc load
6. CONCLUSION AND FUTURE ENHANCEMENT

With the fast growing demand of smart devices like IoT systems, the energy management and sustainable power supply research is being conducted widely. This paper proposes integration of IoT with the hybrid energy technology namely solar energy and TEG. Even though TEG are able to harvest enough energy, the voltage produced is not enough to operate various loads. Hence Integration of renewal energy source along with TEG is proposed, especially in commercial areas where need of electricity is more. It causes no effect on nature i.e. pollution free, at the same time not proneness any kind of accident due to lightning. It is also useful to minimize power supply load i.e. cut short power charge. By using this system, electricity charge is very less and requires less maintenance charge for the equipment.

The designing of this equipment is done in such a way that it is very compact and acts as user friendly. The cost of energy harvesting through this hybrid source can be reduced if it is manufactured in large scale. And becomes much affordable. Due to this technology, the power shedding or power failure problems can be easily rectified at all times. Hence, it is the most reliable renewable power or electricity resources with less expenditure.

In this paper, not only the energy harvesting by solar energy and thermoelectricity is discussed but also proper voltage regulation using a DC–DC converter to boost the output voltage and also proper energy management using IoT is also discussed. This project is at an intermediate stage in its research and soon will have the potential to explore in market with enabling technology.

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