"IoT Based Biogas Automation and Enhancement Using Photovoltaic Cell"

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Abstract: This project attempts to solve the issues with the Bio Gas plants in rural areas, Issues related to the measuring the volume of biogas consumption and interruption of grid power for catering booster pump are identified. IOT based scheme for measuring the run time of the booster pump and there by calculating the volume of gas consumption and solar photovoltaic based system to provide uninterrupted power supply will be developed. For making the system more economic, DC booster pumps will be developed over AC booster pumps.

Index Terms- ***IoT, Bio Gas, Photovoltaic.***

I. INTRODUCTION

India is the third largest consumer of energy in the world after China and the United States. India's modernization and dynamic economic growth results in the continuing need for energy supply. Energy availability is of greater importance since it I necessary to sustain the growth in all spheres. In another 25 years, three to four times increase in the energy consumption rate is expected over the current energy consumption rate. India is expected to face challenges in meeting the energy requirement of the country with the present growth rate and energy demand. Providing adequate energy of the desired quality to its users in a sustainable manner and at reasonablecosts is vital for continuing the growth rate [1].

Direct using of biomass is inefficient since procuring the fuel takes time. Also, it has severe negative effects on the health of the user. 400 million people in India are exposed to the negative health effects caused due to the indoor air pollution from the use of biomass. This would result in pulmonary, respiratory and vision associated problems [2,3].

In India, according to census 2011 approximately 80million rural households have cattle and more than 25million households generate enough animal wastes that can be processed into biogas & bio-manure. It is observed that the biogas production within the country was about 20,757lakh m^3 in 2014 - 15. This amount is equivalent to 6.6 crore domestic LPG cylinders [4,5]. So, in this project we are trying to overcome these challenges by adapting photovoltaic cell as well as Solar Panel.

II. BACKGROUND THEORY

IoT: The Internet of Things is a system of interrelated computing devices, mechanical and digital machines provided with unique identifiers (UIDS) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. The definition of the Internet of things has evolved due to the convergence of multiple technologies, real-time analytics, machine learning, commodity sensors and embedded systems [6].

There are a number of serious concerns about dangers in the growth of IoT, especially in the areas of privacy and security, and consequently industry and governmental moves to address these concerns have begun. There are many technologies that enable the IoT. Crucial to the field is the network used to communicate between devices of an IoT installation, a role that several wireless or wired technologies may fulfill [7].

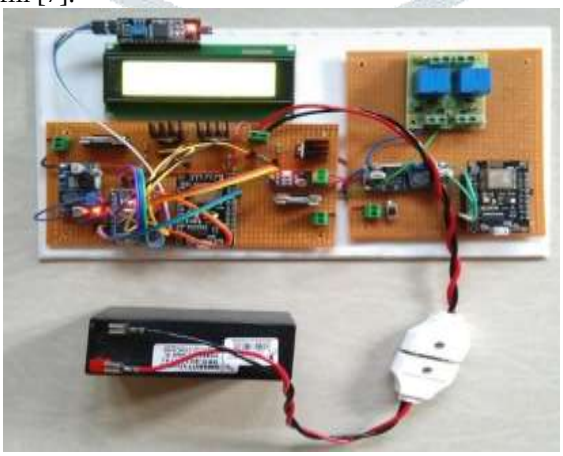

Figure 3.1: Biogas consumption details through Wi-Fi module

Working Principle: An IoT system consists of sensors/devices which "talk" to the cloud through some kind of connectivity. Once the data gets to the cloud, software processes it and then might decide to perform an action, such as sending an alert or automatically adjusting the sensors/devices without the need for the user [8,9].

III. SYSTEM REQUIREMENT

To obtain the desired results we require a system which is reliable, secure and efficient. The System requires compact package of hardware and software. It must fulfill the necessary qualities such as real-time continuous monitoring and exact statistic series. It must support mobility and less power consumption.

3.1 Hardware architecture

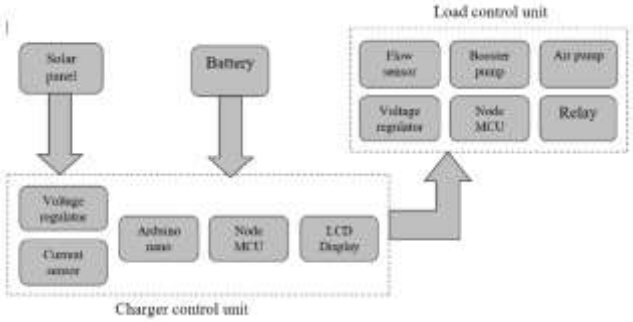

Figure 3.1: Block diagram of biogas automation system

The hardware structure mainly integrates the solar panel, battery (MPPT), voltage regulator, current sensor, Arduino nano (ATmega328), node MCU, temperature sensor and LCD display gives 7 parameters as the charger control unit. Voltage regulator, node MCU, relay, air pump, booster pump, flow sensor and LPG sensor as load control unit. Diodes, MOSFETs, fuse, resistors, switches and connecting wires are the other components. The block diagram of IoT based biogas automation system consists of charger control unit and load control unit. Control unit which provides uninterrupted power supply from solar panel and battery, the actual parameters of panel can be view through LCD display by using sensors and WI-FI module. Load unit is to measure the flow of air and its volume at real time. The real time data can be viewed through android phone [10].

3.2 Software Architecture

If supply is available battery is used else solar panel helps in continuous supply. Voltage and current values from nano are sent to Node MCU in the form of strings, which is further sent to cloud by node MCU.

Voltage Regulator converts 12V from Battery/Solar panel to 5V. Arduino nano collects data from Current Sensor and Solar panel. Arduino nano is a Wi-Fi module which sends collected data to IOT. These parameters are also displayed on LCD display and it displays 7 parameters [11].

In the second part, Relay is used as Switch for protections. Voltage Regulator converts 5V to12V.Flow sensor checks the flow and volume of the boosted air which is sucked from surrounding. Node MCU collects data from LPG sensor, air sensor and connects it to the IOT /Cloud. These real time data are displayed through Android mobiles

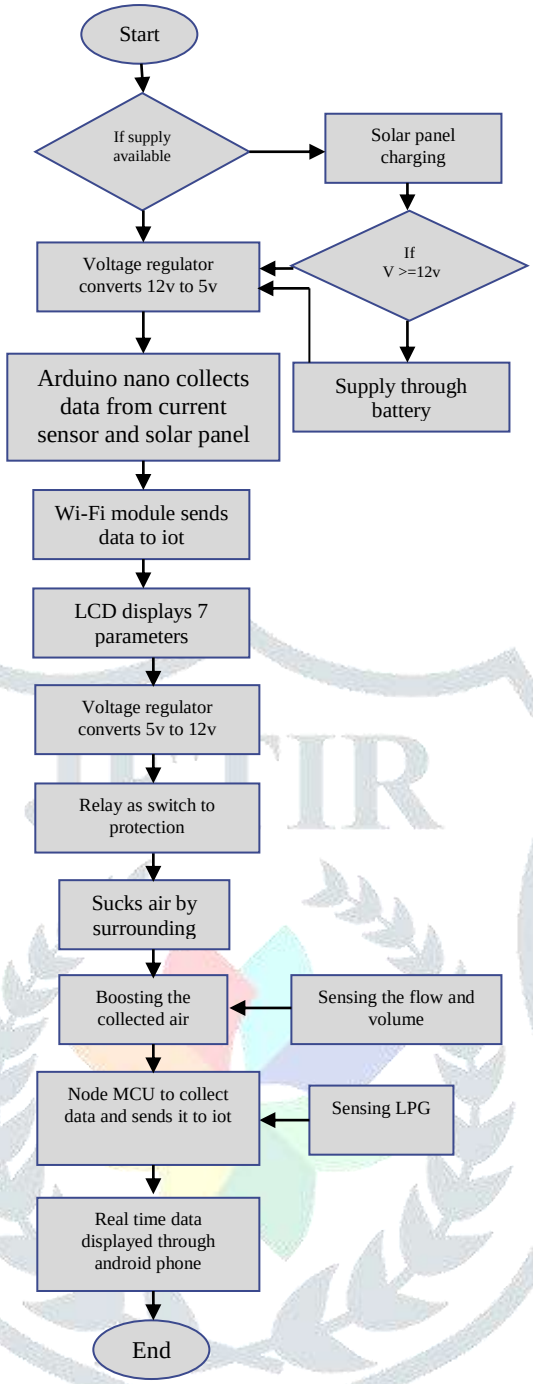

Figure 3.2: Flow chart of automated biogas plant

3.3 SENSORS

3.3.1 Current Sensor

A current sensor is a device that detects electric current in a wire and generates a signal proportional to that current. The generated signal can be then used to display the measured current in an LCD, or can be stored for further analysis in a data acquisition system, or can be used for the purpose of control [12].

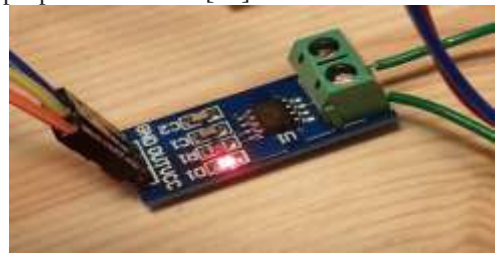

Figure 3.3(a): Current sensor

3.3.2 LPG Sensor

This is a simple-to-use liquefied petroleum gas (LPG) sensor, suitable for sensing LPG (composed of mostly propane and butane) concentrations in the air.The sensor's output is an analog resistance[12].

Figure 3.3(b): LPG sensor

3.3.3 Temperature Sensor

A temperature sensor is an electronic device that measures the temperature of its environment and converts the input data into electronic data to record, monitor, or signal temperature changes [13].

Figure 3.3(c): Temperature sensor

3.3.4 Flow Sensor

Flow sensors are devices used for measuring the flow rate or quantity of a moving liquid or gas. These sensors are generally part of a flow meter that would help to measure the flow rate [12].

Figure 3.3(d): Flow sensor

3.4 ARDUINO

3.4.1 Arduino Nano

The **ARDUINO NANO** is a small, complete, breadboard-friendly board based on the ATmega328P; Offers the same connectivity and spaces of the UNO board in a smaller form factor. The Arduino Nano is programmed using the Arduino Software (IDE), our Integrated Development Environment common to all our boards and running both online and offline [12].

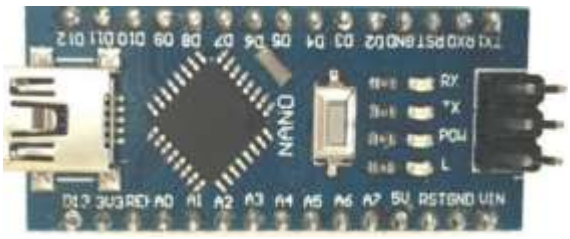

Figure 3.4(a): PIN configuration of ARDUINO NANO

3.4.2 Node MCU

The Node MCU is an open source software and hardware development environment that is built around a very inexpensive system on a chip (SoC) called the ESP8266. The Node MCU is a software that comes installed in an ESP8266 and uses Lua programming language that can be programmed via Arduino IDE [12].

Figure 3.4(b): Node MCU Wi-Fi Module

3.5 DISPLAY

3.5.1 LCD Display

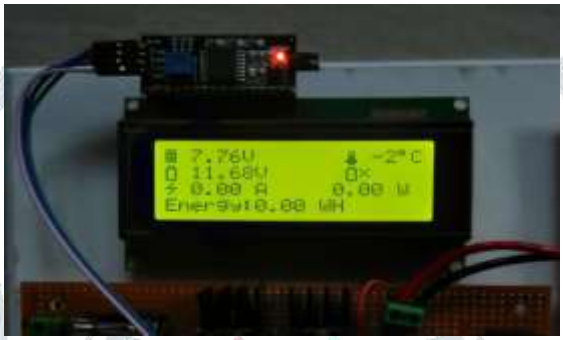

Figure34.5(a): LCD Display

Liquid – crystal display (LCD) is a flat panel display that uses the light modulating properties of liquid crystals combined with polarizers. Liquid crystals do not emit light directly, instead they use a backlight or a reflector to produce images in color. The main advantage is that it is very compact, thin and light and also it is less power consuming. They are used in wide range of applications including computer monitors, television etc. [13].

3.5.2 Ubidots

Figure 4.5(b): Ubidots

Ubidots is an Internet of Things (IoT) data analytics and visualization company. It turns the sensors data into information that matters for machine – to – machine interaction, educational research. Ubidots exists as an easy and affordable means to integrate the power of the IoT into a business or a research [14].

IV. RESULTS & DISCUSSIONS

4.1 RESULT

IoT based system is implemented to measure seven parameters in control unit such as voltage in solar panel, voltage in battery, current in the charge control unit, room temperature, power supply status, power and energy of the solar panel.

Figure 4.1: Measurement of parameters

The second objective is to supply uninterrupted power. So, we use solar panel of 12V and 45W to convert solar energy into electrical energy and thereby it is useful when power supply is interrupted.

Figure 4.2: Uninterrupted supply through solar panel

Steady supply of biogas is supplied with the help of booster pump. Booster pump boosts the air sucked by the air pump by increasing the pressure of the air. The booster pump extracts the remaining gas efficiently and supplies the system. Hence, steady state of biogas is supplied to the system.

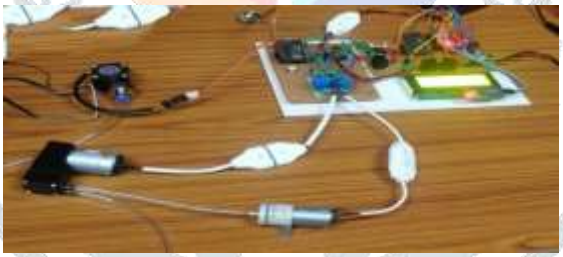

Figure 4.3: Steady supply of biogas

DC booster pump is used instead of AC booster pump because DC booster pump can operate directly from a battery making them more convenient and portable. Speed control and operation is simple in DC booster pump and hence they are more energy efficient.

4.2 CONCLUSION

The paper focuses on automation of biogas plant based on IoT technology which is used to enhance the efficiency, promote renewable energy resource and to lower the maintenance cost of biogas plant. This system is implemented to measure the run time of the booster pump and thereby measuring the volume of the biogas consumption with the help of flow sensor by which we get to know the remaining biogas in the digester for further usage. Solar photovoltaic based system is implemented to assure uninterrupted power supply, which helps to continue the process without interruption especially in rural areas where power supply is not efficient. With the help of DC booster pump the cost of the system is reduced and hence economic for rural or underdeveloped areas. For further development, insertion of a greater number of sensors and smart devices can be done which leads to increase in efficiency of the biogas plant. By automating the plant using IoT, the amount of biogas to be produced in future days is known and flow of gas to the load is calculated, the data regarding gas consumption and production is recorded in a platform which can be used to solve issues related to biogas operating system. In future we can extend this project by connecting more sensors and devices to bring further automations in biogas applications and reduce its initial cost.

V. ACKNOWLEDGEMENT

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