ISSN XXXX XXXX © 2017 IJESC

Research Article Volume 7 Issue No.6

Design and Development of Miniature Model of Micro-Grid for Generation of Small Power using Distributed Generation

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Abstract:
Generation of electric power and satisfying the electric demand has been a tremendous challenging task at present situation. The increases in the transmission losses and decrease in efficiency has made increase in the generation cost. The electric power generation depends on the conventional sources of energy. In the future a situation may occur for alternative generation of electric power due to the depletion of nonrenewable sources of energy. The current growth in rate of population has caused the increase in the electricity demand, and also increases in generation of electricity. The supply of electricity to remote area through main grid is complex, to avoid such issues a new concept has been evolved called Micro Grid. The implementation of micro grids improves the reliability and flexibility of the system, reduces the cost of energy transmission and distribution, and increases the penetration of renewable sources. Micro grids use renewable energy sources which are eco-friendly and inexhaustible in nature which reduces the demand rate of fossil fuels. Six renewable sources are used to generate electrical energy that is Solar, Wind, Piezoelectric, Garbage waste, Saline water and Speed breaker. The power generated from different energy sources is stored in the battery intern supplying load. The stored electrical energy is utilized for two loads that is Tollgate and automatic Street light system. This micro grid can be implemented in the metropolitan cities and remote areas.

Keywords: Distributed Generation, Micro grid, Renewable Energy Resources

I. INTRODUCTION

"An electrical grid is an interconnected network for providing electricity from generating stations to consumers". Generally grids are centralized grid they are connected with longer transmission lines due to which more transmission losses takes place. To avoid these traditional techniques new concept has been evolved called Micro grid where electricity can be generated on rooftop such as solar, wind etc., This paper proposed the detailed report on usage of micro grid and the distributed generation in the future scenario. The depletion of non renewable source of energy such as coal, petroleum, fossil fuels and natural gases also eradication of such resource causes the trouble for generation of power. Micro grid gives the complete solution for power generation in the upcoming years.
The increase in growth rate and improvement in the field of technology causes more consumption of electricity and demand for the electric power generation. Micro grid and Distributed generation gives the complete solution to the rate of energy demand. These Micro grids use renewable energy sources which are eco-friendly and inexhaustible in nature. This allows the reduction in demand rate of fossil fuels.

A. Introduction to Micro Grid

Micro grid concept was established several years ago to integrate all the renewable energy sources. Since micro grid uses renewable energy and are flexible in nature, because of these power can generated in rural and remote control areas. Micro grid acquires less space in which generation takes place near the load hence reduces the transmission losses and the efficiency can be increased. A micro grid can be operated in two ways as interconnected mode and island-mode. In interconnected mode where power is supplied to the traditional or main grid and in island mode it has the capability to generate power independently and are disconnected from the main grid. A Micro grid has been defined in several ways by different research university as A definition from U.S. Department of energy Micro grid exchange group states "A Micro grid is a group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that act as a single controllable entity with respect to the grid".

B. Introduction to Distributed Generation

Distributed generation is defined as generation of electric power in limited size (i.e., ranging from 1kW to 10,000kW) which is directly connected to the distribution system of power network. This generation is also called as 'decentralized' or 'embedded generation'. In decentralized power generation power is generated away from main centers and connected to local loads directly. Conventional power such as coal, gas and nuclear power plants are centralized which requires electricity to be transmitted over a longer distances. Distributed generations are more flexible, will be placed near the distribution network and the selection of site will be made depending on type of sources used. In local power transmission no point of losses but in centralized system where a transmission loss takes place due to the effect of transformer and transmission lines.

II. LITERATURE SURVEY

A. Literature on Micro Grid

The interconnection of small generation to low voltage distribution can be termed as the micro grid. Micro Grids can be operated with and without a connection to the main power network. The micro grid helps in reducing the expenditure by reducing the network congestion & line losses and line costs and there by higher efficiency. Micro grid provide higher

flexibility and reliability as it is able to run in both grid connected and islanded mode of operation and its components may be physically close to each other or distributed geographically. The micro grid concept is based on the assumption that large numbers of micro generators are connected to network to lower the need of transmission and high voltage distribution system. However the micro grid can be integrated with the distribution system but it can also produce a threat to the safe and reliable operation of the grid due to the net loss in voltage flow and power quality. [1] [2]

B. Literature on Distributed Generation

The distributed generators communicate with each other for load sharing. This advantage allows the energy security of countries to reduce imports of fossil fuels, which agrees to maintain a lower cost than usual prices and improve the standard of living without harming the environment, especially in a time when the economic crisis is timely. Another advantage, they can easily support the electrical network in remote sites and rural areas. Contribution for the reduction of the losses in the European electricity distribution systems will be a major advantage of micro sources. [3] [4] DG has the potential to increase system reliability and power quality due to the decentralization of supply. Increase in reliability levels can be obtained, if DG is allowed to operate autonomously in transient conditions, namely when the distribution system operation is disturbed upstream in the grid. [4] [5]

C. Literature on Type of Renewable Energy Resources

A renewable resource is a resource which is replaced naturally and can be used again. Examples are: oxygen fresh water, solar energy, timber and biomass.

1) Solar Power Generation:

Solar energy depends on the amount of direct sunlight even though clouds, blue patches, shades and rain also affect direct sunlight. Solar panels are located at areas with best sun exposure. Solar panels are practical where the average sunshine is greater than 5 hours a day. The energy system proposed in this paper seeks to address both issues related to electricity and transportation sectors. [6]

2) Wind Power Generation*:*

Currently, wind power is not in wide use and accounts for the production of only 1% of energy used worldwide .However, wind power generation nearly quadrupled between 1999 and 2005 with top producers being Germany, Spain and the U.S. In Holland, wind supplies 20% of the nation's energy, the highest percentage of any country. Wind energy depends mostly on wind speed and kinetic energy of the air mass even though wind speed is also affected by air density, air temperature, air barometric pressure, altitude, and local terrain. Wind generators are practical where the average wind speed is greater than 4.5m/s and with constant flow rate at minimum turbulence and minimum powerful wind bursts. [7] [8]

3) Piezoelectric Generation:

Walking is the most common activity in a day life. While walking, the person loses energy to the surface in the form of vibration. This energy can be utilized and converted into electrical energy. In this paper, piezoelectric crystals are used as a medium. These piezoelectric crystals convert the mechanical vibrations into electrical energy. [9]

4) Generation of Electricity Using Saline Water:

Seawater power generation is the best new energy solution for coastal regions and countries with oceanic climate, as it makes effective use of natural resources. By keeping this in mind we explore some simple experiments involving homemade seawater power generation that are not only instructive, but which we can drive low-power devices. The paper proposed uses the process of splitting up substances that conducts electricity when in the molten state or in solution. [10] [11]

5) Power Generation Using Speed Breaker:

In this, we mainly focused on the principle of "potential energy to electrical energy conversion". The proposed concept with simple arrangements, it is easy to produce electrical energy for the working of streetlights, lamppost and the cost is less. A large amount of energy is wasted at the speed breakers through the dissipation of heat and through frictions, every time a vehicle passes over it. There is great possibility of tapping this energy and generating power by making the speed-breaker as a power generation unit. [12]

III. BLOCK DIAGRAM AND DESCRIPTION

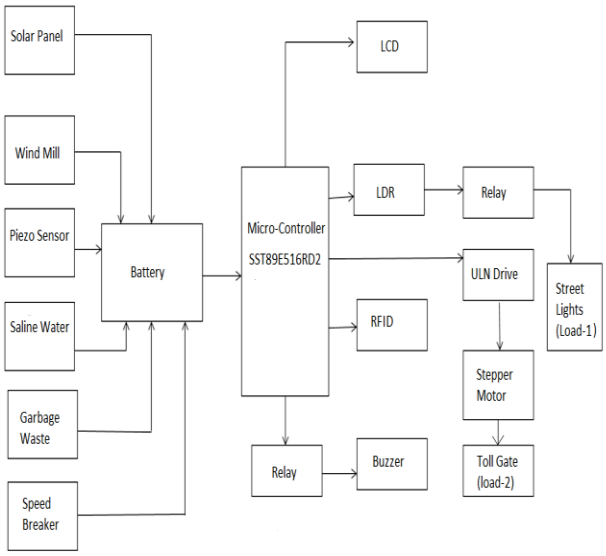

Figure.1. Block Diagram

A. Working Principle

The power is generated from the entire six renewable sources and the power is supplied to the rechargeable battery for the storage purpose then the power is utilized for automatic street light, domestic purpose and tollgate operation. The power from the battery is supplied to the 8051 PCB Board. The voltage regulator in the board provides 5V. The power is supplied to the SST89E516RD2 microcontroller which operates LCD, ULN Drive, RFID Reader and Buzzer. An LCD displays the present operating condition of the tollgate and this is controlled by micro controller connected at port2. The operation of stepper motor is done by ULN2803 which provides the interconnection between the microcontroller and stepper motor and these is connected to port1.ULN Drive also reduces the voltage required to drive the heavy stepper motor to 5V. The RFID tag is scanned through the RFID reader and the scanned code will be sent to the microcontroller which will be in RS level is converted to TTL language by MAX232 if the tag is valid the tollgate get open, if not the buzzer indicates that card is invalid and gate remains closed lastly if card is low balance then it has to be recharged and gate should be opened manually. The LDR sensor is used for light detection which helps in automatic street light operation. These LDR Sensors are connected to relay for opening and closing of circuit.

IV. AIM, OBJECTIVE and METHODOLOGY

A. Aim

Design and Implementation of Micro Grid for Generation of Small Power Using Distributed Generation in Standalone Mode.

B. Objectives

1. To review the literature on micro grid and distributed generation for small electric power.

2. To arrive at design specification of various power generating units:
a. Solar power generation.
b. Wind power generation.
c. Power generation using piezoelectric sensor.
d. Power generation using garbage and saline water.
e. Power generation from speed breaker.

3. To design power electronic circuit for converting AC to DC and microcontroller programming for control of different operation.

4. To integrate all the different power generating unit, control and store power in the battery.

5. To test the fabricated micro grid and flow of power to the load.

C. Methodologies

1) ***Methodology for Objective 1:*** To do the literature survey on different power generation and micro grid by understanding the current national and international status and developments made in distributed generations and micro grid.

2) ***Methodology for Objective 2:*** The selection solar panel, piezoelectric sensors, wind blades according to required power generation and designing the power generation units.

3) ***Methodology for Objective 3:*** The designed control circuit will be simulated using PROTEUS platform and its characteristics will be observed. The program is developed for the working of LCD, Stepper motor and UART drive.

4) ***Methodology for Objective 4:*** To integrate all the power generation and supply the power to rechargeable battery through rectified output of voltage regulator.

5) ***Methodology for Objective 5:*** The finalized design of power generating units will be fabricated after choosing the appropriate components and the power is given to the loads. The advantages of new design of overall circuit validated against the performance of existing systems.

V. RESULT

In the project, an attempt has been made to design a small model of micro grid power generation using distributed generation. It consists of working miniature model of 6 different power generation units. The power generated from each unit is supplied to the battery and intern different loads. The output from each generating unit is shown below:

A. Output Obtained Across Solar Panel

Figure .1 .Output Voltage of Photovoltaic Panel

A typical photovoltaic cell consisting of 72 individual cells in series with each cell producing a voltage of 0.33V will produce an output voltage of 24V. From the above Figure .1 observe that the output voltage obtained across solar panel is 4.02V.

B. Output Generated Across Wind Mill

Figure.2. Output Voltage and Speed Across Wind Turbine

Table.1. Voltage Vs Speed in Wind Turbine

Experimental Observation of Speed of Rotor (RPM)	Observed Voltage (Volts)
1500	11.9
600	10.5
550	9.9
415	9.2

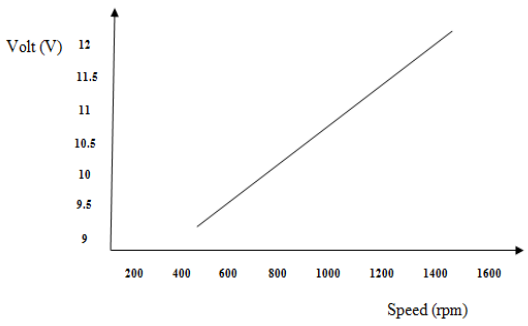

Figure.3. Graph of Voltage Vs Speed

C. Output Generated Across Piezoelectric

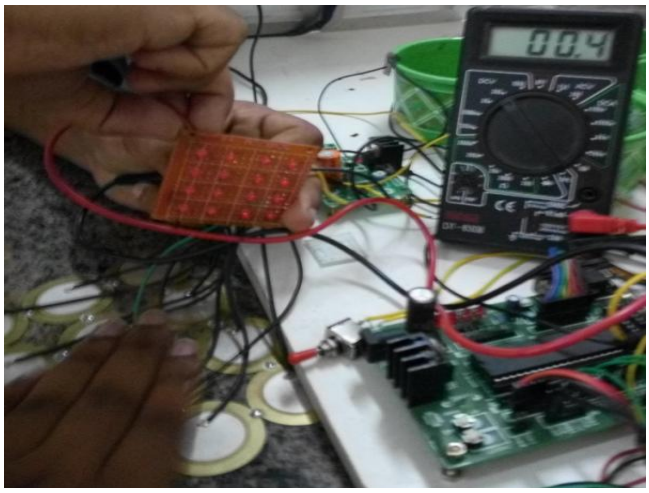

Figure.4. Output Voltage Across Piezoelectric Sensor

Figure.4 shows the output voltage obtained from the piezoelectric sensor. Here we are using 12 pieces of piezoelectric sensor which are connected in series which gives an output voltage of 1-.3V depending on the pressure applied.

D. Output Across Garbage Waste and Saline Water

Figure.5. Output Voltage across Saline Water and Garbage Waste

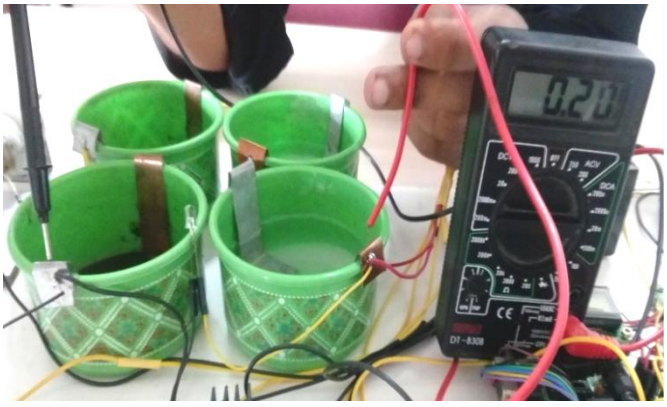

Figure.6. Output Current across Saline Water and Garbage Waste

Figure.5 and Figure.6shows the output voltage and current obtained from garbage waste and saline water. In this project copper and zinc are used as an electrodes struck between common salt and wet waste. About 6grams of copper and 6grams of zinc are used and 25 to 30 grams of common salt and 40garms of wet waste are used to produce electric power. In the above figure voltage of 1.36V and current 0.20mA is observed and gives an output power of 0.272mW is obtained.

E. Voltage across Speed Breaker

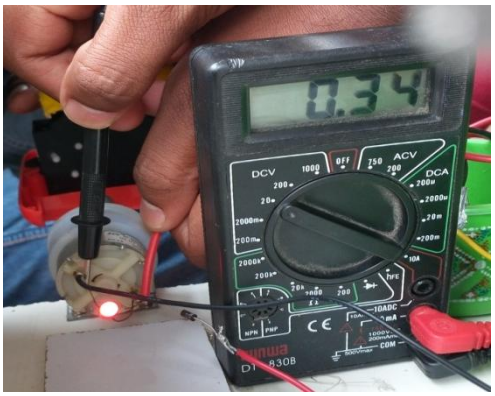

Figure .7. Output Voltage across Speed Breaker

Figure .7 shows the output voltage obtained from the speed breaker. In this project the speed breaker of vibrating type is constructed. When a vehicle crosses the speed breaker, it gets pressed and then it gets back to its original position. Rack and Pinion assembly gives good mounting convenience with maximum gear losses of 3% and efficiency of 95%. Here we obtained an output voltage of 0.34V.

F. Waveform of Adjustable Voltage Regulator

The below, Figure 8 shows the output waveform of adjustable voltage regulator LM317. This project uses 12V rechargeable lead acid battery which requires a constant voltage of 12V to be supplied. As the output voltage obtained from different generating sources are variable and hence to maintain these voltages at constant level, voltage regulator is used. In the above waveform, (green line) shows the DC input of 22V is applied to LM317 voltage regulator and it is observed that the DC output voltage is regulated to 12V (red line) by using variable resistance.

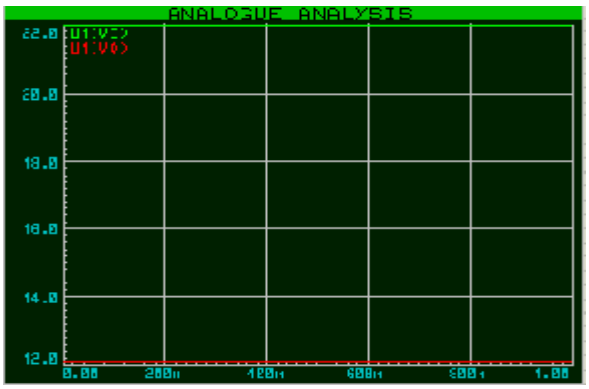

Figure 8 Waveform of Adjustable Voltage Regulator

VI. CONCLUSION

A brief explanation of Micro Grid, different types of connection of micro grid and also usage of different renewable energy resources that can be used to generate electricity has been explained. Micro Grid gave a clear idea of electricity can be supplied to the remote control areas. By using concept of Micro Grid the losses during the transmission can be reduced and also the efficiency, flexibility of the system can be increased. Literature review on various renewable energy resources and the types of Micro Grid gave a broad knowledge on Micro Grid system. Based on the theoretical design and the simulation results obtained, using distributed generation prototype model of stand-alone micro grid has been constructed which includes Solar, Wind, piezoelectric, Speed

breaker, wet waste and Garbage waste generation. The power output from each source is stored in the battery of 12v. By the usage of Automatic Street light and tollgate system as load the power can be utilized and efficiency can be increased. A miniature model demonstration with electricity generation from different renewable sources is achieved. The same concept can be implemented in the future for development of grid system to satisfy the electricity demand.

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