iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 8 **Issue:** IV **Month of publication:** April 2020

DOI:

www.ijraset.com

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue IV Apr 2020- Available at www.ijraset.com

Fuzzy Logic based Energy Management Unit for Residential Smart Micro-Grid

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Abstract: ***Microgrid is a challenging Technology now days. It is very useful for World in future. In this paper, we have proposed Energy management unit for microgrid implementation. Microgrid is very helpful in reducing power blackout. We proposed to develop our own microgrid for residential uses or industries in order to minimize the electricity use from Maharashtra state electricity distribution company limited(MSEB).***
It is Environment friendly as we use Renewable Energy Sources as input to microgrid. For controlling Ac and DC loads fuzzy control logic is used. In proposed grid we have used one controller which will monitor the power generation and Energy usage. Output load of the grid can be of AC as well as DC type.
We can handle the output by giving priorities to them in specific time duration. We can also display data in digital format using controller. TTL to UART converter is used to display data on pc. The displayed on pc is energy generation, power utilization, and cost profile.
Keywords: Controller, AC/DC loads, Renewable Sources, Microgrid, Load Requirement

I. INTRODUCTION

Power is a crucial element now days. As industries are increased thus energy requirement is also increased now days. Therefore, Energy blackout problems are also face by industries or residential areas. According to World Electricity generation by source, 2015, electricity generated by fossil fuel is 66.2%, by nuclear is 10.7%, by hydrogen is 16.4%, by wind energy is 3.5%, by solar is 1.1% and by other renewable energy is 2.2%.
These statistics shows energy generated by solar is very less as compared to other sources. But solar is very efficient and environment friendly, thus we have used solar as main energy source in our research. Also solar cannot be useful at the night time, thus to store energy generated from solar batteries can be used.
For industries power requirement at daytime as well as night time. Thus batteries can be used to provide energy at night time. In industries and residential areas both AC as well as DC loads are used. For that microgrid should be able to operate for AC as well as DC load. Controller is used to operate AC and DC load. For example, if we take engineering college campus, there are many departments, different buildings, hostel, etc.
During specific amount of time, some building use less power while some buildings use more power. If power generation in solar is limited then we can cut off the power of the building temporarily which is not in use currently. For this purpose, one can assign priorities to various buildings and controller can control load depending on priorities given. If the power generation in microgrid is less then grid can also take power from MSEB, while if energy generated in solar is excessive then we can provide energy back to the main grid i.e., MSEB. Inverter can be used to provide energy back to the main grid. Controller use fuzzy logic to control output parameters.

II. METHODOLOGY

A. Hardware Components

The proposed grid requires various types of hardware components. Hardware like solar panels, batteries, inverters, controller, output load are used in proposed grid. Different AC/DC loads can be used as an output. One can use lamp, fan, LED's as output load. Relays can also be used in order to operate 12Volts load. In this way hardware components can be collected.

B. Software Simulation

First software simulation can be used for checking efficiency of code and system. First code is dump in controller in simulation software in order to protect the controller from any damage. We have used many software's like orcad, mikroC avr, proteus, multisim, flash magic, etc.

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III. CONSTRUCTION

This paper shows construction of residential microgrid. For the construction of residential microgrid, many hardware components specifications are taken into considerations. Input resources to the microgrid can be of various types. We have used solar panel as input source to the microgrid. Solar panel used solar energy to generate electricity. It is nonrenewable source of energy. One can use many solar panels in series to generate more amount of energy. We have used solar panel that can generate 10 watt of power. we use battery store energy and supply energy to loads when it requires. Battery can be various types. we have used lead acid battery. In lead acid battery positive electrode is lead oxide(PbO4). And negative electrode is lead (Pb). Both positive and negative electrode are soaked in sulphuric acid solution which is called as dielectric solution. Dielectric solution is 75% acid and 25% water. It has ratio of acid to water as 3:1. One can use many batteries in series to provide maximum voltage at output. Controller can be choose on the basis of input and output required. We have use atmega controller. It is 40 pin controller. It uses RISC 8 bit AVR CPU. It has RAM of 2048 bytes. It contains flash memory. Relay are also used in the microgrid for on/off operation. Relays are driven by transistor. BC547 transistor is most common transistor to drive relay. A voltage sensor is a device that detects electric voltage in a wire, and generates a signal proportional to that voltage. A current sensor is used to detect the electric current through the wire. It generates corresponding digital value. The generated signal could be analog voltage or even a digital output. The electrical signal generated is used to display the measured voltage in a voltmeter. It can also be used for the control purpose. Preset is used as voltage sensor here. The generated signal could be analog current or even a digital output. The electrical signal generated is used to display the measured current in an ammeter. It can also be used for the control purpose. ACS 712 is used as current sensor here. Also in proposed microgrid, data can be displayed on respective terminal also. For that purpose, daily power generation data and power used data is stored by means of computer or any other energy storing device. Here, we have used computer to store and display collected data. UART stands for Universal Asynchronous Receiver and Transmitter. UART to TTL converter is used in order to transmit data from controller to computer. RS232 converter is used here to transmit data from UART to TTL. It operates on 3.3 Volts supply voltage which will be drive from controller. Output of the grid can be any AC/DC load. Here we have used some AC load as well as some DC load. AC load used is 230 volts' lamp whereas DC loads used are LED strips. Fig 1. Shows block diagram of microgrid. It shows interfacing of different components used in microgrid. It contains power supply of 5 volts. Any renewable energy source can be used in replacement of solar panel. Excess power is fed back to the main grid. For this **purpose,** we have used inverter here. Inverter will convert DC power into AC power which will be followed by step up transformer. The step up transformer will then increase output power and then 230 Volts power will be given back to the main grid. In this way microgrid can be designed according to the daily load used and power requirements.

IV. OPERATION

Operation of proposed grid is very simple to understand. Microgrid device models, including distributed energy sources and loads, as well as their control algorithms, are being developed. Several case studies were simulated to evaluate the operation of the smart microgrid during parallel and islanded operation modes.

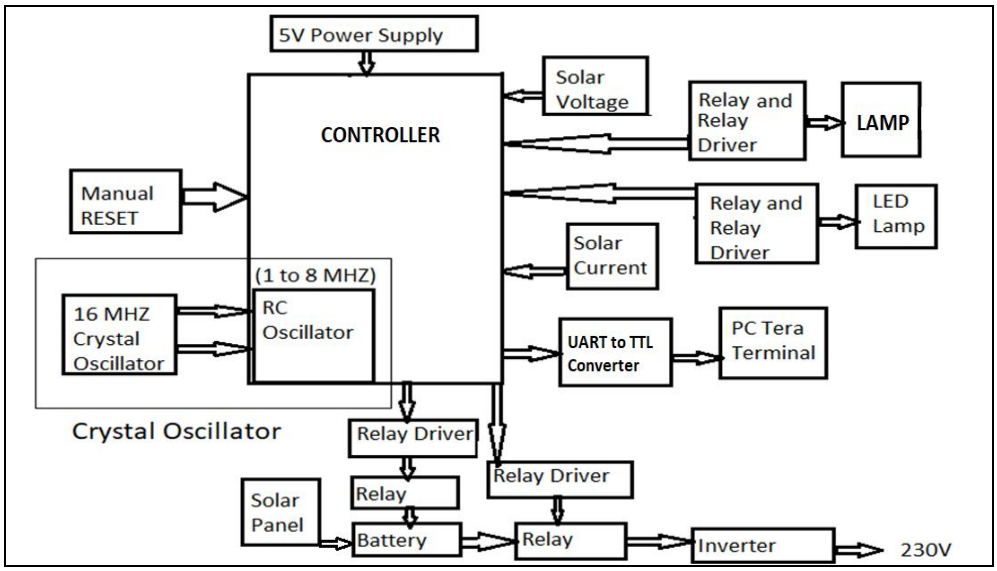

Fig. 1. Block Diagram of Micro-Grid

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
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Program code is usually stored in ROM of the controller as for safety purpose and not a hard disk memory of the computer. Generally, the user of the microgrid does not develop any new software for the computer system. Voltage and Current sensors are used to collect data from environment. Preset or voltage diver can act as voltage sensor which is given to ADC pins of controller. Preset is connected across solar panel to measure voltage generated by solar panel. Here, ACS 712 current sensor is used to measure current through solar panel which is connected in series with solar panel. In proposed grid, solar panel is used as source followed by battery. Power generated from solar panel is displayed on PC by means of voltage and current using UART to TTL converter. Thus data is displayed on PC. At the output side residential load is connected as fan and LED lamp. As controller output is restricted to 5 V, relay driver circuit and relay is used to drive voltage of 12 V required for residential load. Battery is charged by means of solar panel.

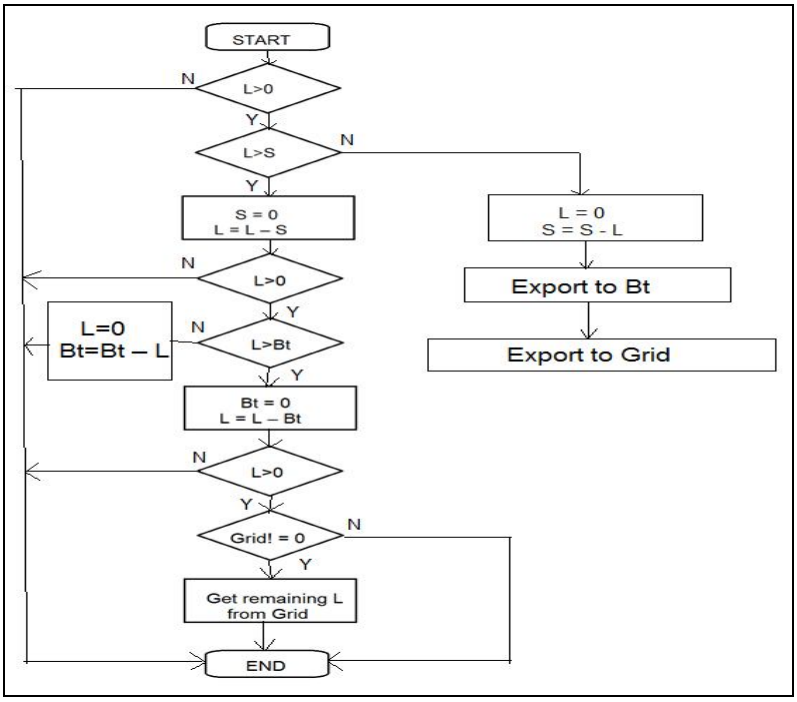

Fig. 2. Flow Chart of Micro-Grid

If excess power is present in battery, then it is given back to utility grid. Inverter is used for this purpose which provide output of 230 V. Energy Management Unit (EMU) is one of the most dominant research wings which consist of several agents who interact with each other to achieve a common objective. Fig. 1 shows block diagram of the proposed microgrid. It contains different components used in proposed grid. EMU has been developed for a wide range of applications in power systems. The implementation of the system has been done using an Atmega controller. Above Fig. 2, shows flow chart of residential smart microgrid. It explains flow of power from grid to the load. For an efficient and economic operation, the working of these systems needs to be accurately monitored, controlled and coordinated using various strategies. Among the various control strategies that are available, the one that is most effectual and frequently used is the EMU model. It is evident that an attempt to develop an open source microcontroller based energy management unit coded using Embedded C for microgrid control and communication applications. The reason for simplification lies in the fact systems need to be easily configured for usage in rural areas and the number of functions required are far lesser compared to those required by an urban microgrid. For better understanding of flow of project flow chart is shown in Fig. 2. The environment variables i.e. Load Demand, Solar Generation, State of Charge of the Battery, Information on grid availability are sensed through the voltage, current sensor that are given to the microcontroller. Using these values, the program calculates the optimal power distribution. This is reflected in microcontroller which is given to the physical device for actuation (LEDs). In the flow chart, initially the load gets power from solar panel. Then the remaining excess solar power is used to charge the battery and finally the excess power is given to the grid. If the power at load side is low, then load will receive power from the solar and then from the battery. If the grid is having excess power, then the remained required power is received from the grid. During the grid outage the microgrid gets isolated and it balances the power requirement by appropriate load shedding.

V. RESULT

The main objective of this study is to develop an energy management control system, based on fuzzy logic, which performs in such way that all the energy from the renewable sources is used. The electrical energy can also be obtained from the power grid. In this way, the best cost-performance trade off with minimum storage capacity and maximum utilization of the renewable energy can be obtained.

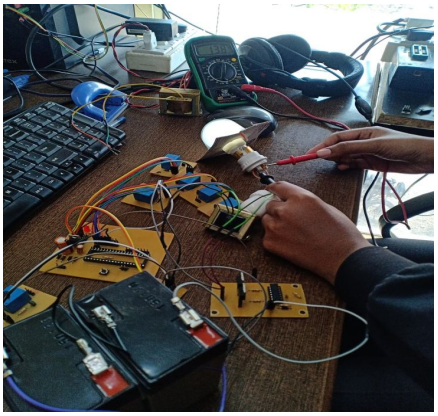

Fig. 3. Output of Micro-Grid

In this, solar panel is connected to the controller ATmega 32 and battery (6 Volts, 5.5 Amp-Hr) is also connected to the controller ATmega 32. Also current sensor ACS 712 and preset as voltage sensor is connected to the controller ATmega to measure voltage generated by solar panel. Voltage is measured using preset which is connected across solar panel.

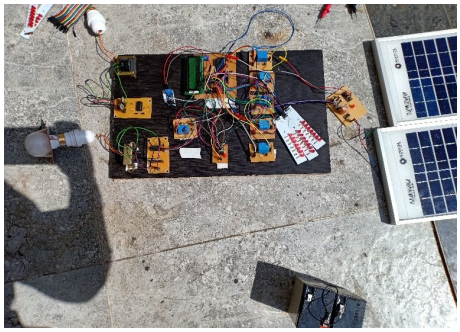

Fig. 4. Setup of Micro-Grid

Output is seen on flash magic software, we use terminal to see the output voltage. Voltage is measured in day time voltage values are 12 Volts. Solar is most active during day time thus it is generating 12 Volts output. Also Fig. 3 and Fig. 4 shows required output of project. Voltage is measured in day time thus voltage values are 12 Volts. Solar is most active during day time thus it is generating 12 Volts output. Fig. 3 shows Output of Micro-Grid which is energy given back to the utility grid. It shows AC load as the output. Thus whenever the power generation in grid is more, the excess power will be given to grid, here to AC load and AC lamp will glow. Also, Fig. 4 shows the actual setup of Micro-Grid. In this way smart microgrid can be implement.

VI. CONCLUSION

The energy management of micro-grids is implemented in network of micro-grids. A mode transition strategy is designed to smooth the mode variation. Rural areas face problem due to shortage of electricity as electricity consumption in industries and urban areas is more. Installation of residential Smart Micro Grid will help in large amount of generation and storage of electricity.

VII. ACKNOWLEDGMENT

This project gives us a chance to get in touch with the practical aspects of engineering. We are grateful to our project guide prof. V. A. Kulkarni for immense support and keen interest shown in project. We also express our deepest thanks to our HOD Dr. M. T. Kolte who has provided us with support and guidance whenever required. We are also grateful to our principle Dr. N. B. Chopade for his constant encouragement and support. We are deeply in depth to our beloved parents whose continuous support helped us achieving our inspiration academically.

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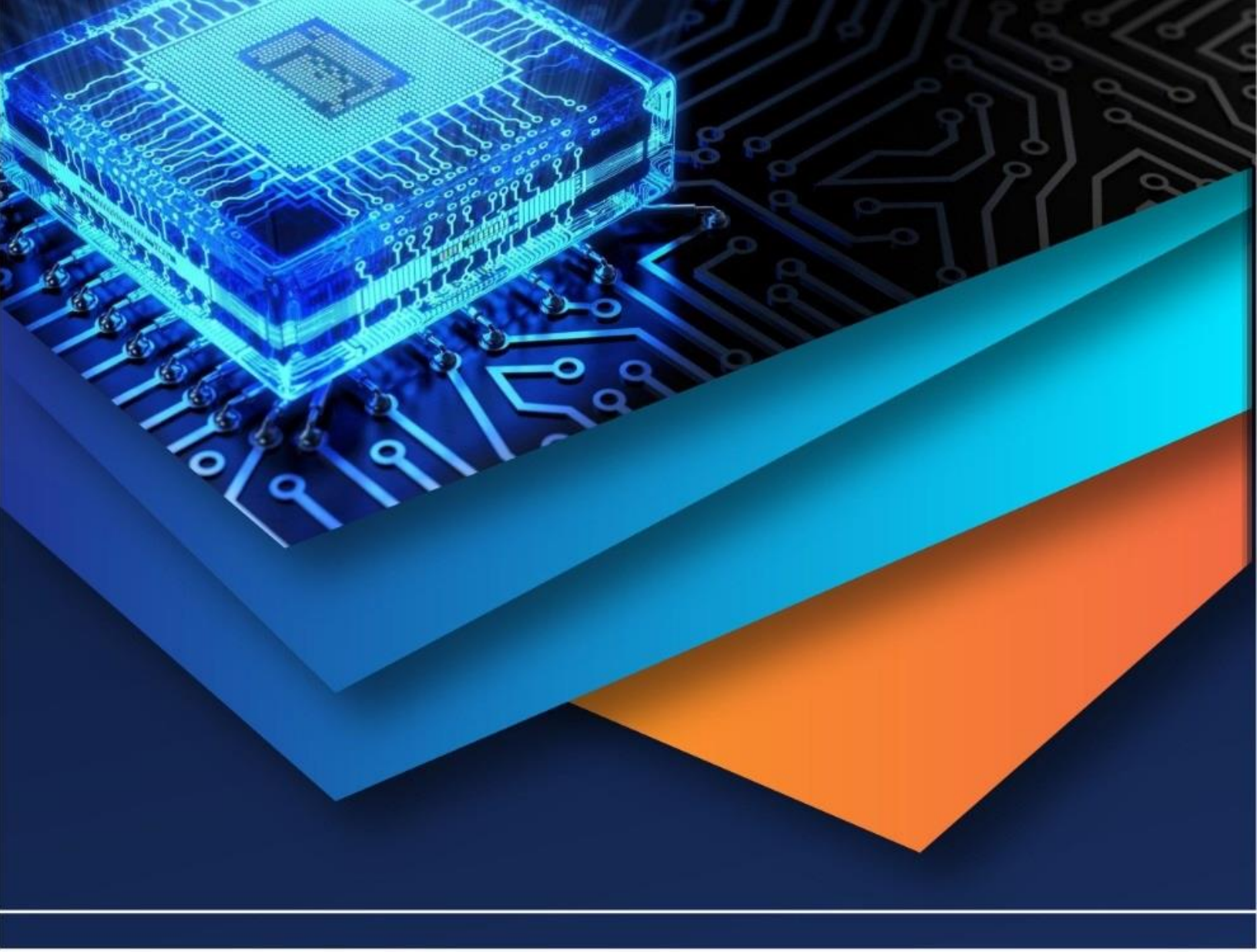

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