Uninterruptible Power Supply With Multiple Power Sources By Using Fuzzy Controller

V. Ravichandran[1], V. Manikandan[2], M. Santhosh[3], S.Sudarsan[4]
[1]Assistant Professor, Dept of EEE
[2, 3, 4]Dept of EEE
[1, 2, 3, 4] Nandha Engineering College(Autonomous),Erode, TamilNadu, India.

Abstract- *The uninterruptible power supply with multiple power sources helps to switch the power supply depends upon the load demand (or) need. This system helps to run critical load wherever the load must to run constantly. However, from the point of view of energy saving, reducing cost and reduces the usage of EB supply which is lead to reduce the usage of fuels. This project proposes the efficient power management system for critical loads.*

This project has presented the critical load which is driven by the multiple power sources. The performance of the multiple power source system has been realized by our control scheme which has been implemented both in the simulation and in the experiments. By using fuzzy control method which is sophisticated method, to encounter the problem PIC controller is used which is controlled by fuzzy controller to driven the system with the help of feedback.PIC control is a very popular and advance method in microcontroller, which is run, depends upon the algorithm stored in the memory. The control system will work whenever the load variations were detected. By considering the load demand, controller will gives a feedback to operate the relay (or) inverter. The nature of the system is dynamically changing the incoming power supply whenever the need was occur. As the load is satisfied with the power source, the triggering angle of the thyristor will vary to make a correction in the incoming power which is in the inverter section.

Keywords- Multiple power source UPS, Fuzzy logic control, PIC microcontroller, quick response relay, Adaptive depends on load.

I. INTRODUCTION

The unequal provision of resources such as constant electricity supply, good road network, quality health care delivery, and adequate security policies to the rural areas as compared to the urban areas in developing countries has brought about the quest for rural-to-urban migration and high demand of individuals leaving their country to another. thus the need for an alternative means of power generation.

More recently, these farm products are being preserved with the aid of newly developed power electronic system appliances. These appliances are environmentally friendly, thereby making the dependency on fossil fuels a thing of past. It is common knowledge that inadequate power supply results in low productivity and slow economic development. This challenge has made investors shift their attention to the urban areas.

In developed countries, alternative/uninterruptible power supplies are ubiquitous, thus eliminating prolonged power interruptions or total blackout to the utility subscribers. This has encouraged many investors to invest in such regions, leading to reduced cost of living and improved economy. Numerous research efforts have been directed in the area of uninterruptible power supplies (UPS) and changeover systems with different merits and demerits.

There are many classifications of UPS such as OFF-line UPS, ON-line UPS and Line interactive UPS. In OFF-line UPS, the inverter is normally set OFF. The connected loads are fed from the mains utility supply. Once the mains supply is not accessible, a static power switch switches on the inverter and connects it to the load automatically. When the supply is brought back, the inverter is again shut off. The problem with the OFF-line UPS is that they are interrupted momentarily each time the utility supply fails.

In most cases, uninterruptible power supplies are known to change from one AC power source to another AC power source or from AC power source to DC/AC power source in order to maintain stable power to the connected loads in case of any interruption on the actively supplying end.

For instance, if utility power is suddenly off under UPS state, the loads are meant to be connected to a standby AC generator or the output of inverter system (DC/AC power system) in an uninterruptible power supply system between utility power supply and DC/AC system network

This paper presents a multiple power source for the purpose of uninterruptible power supply to the remotest rural

areas. This was achieved by the combination of four power sources that energize DC-AC converter to deliver constant and reliable power supply to rural dwellers. The DC-AC converter that is adopted in this work is known as inverter. The DC-AC converter is powered by alternatively connecting with four power sources.

The solar-DC power network converts solar energy into electrical energy, whereas battery banks convert chemical energy into electrical energy. This shows that there is interaction between solar energy, electrical energy, and chemical energy to accomplish a particular purpose of constant DC power supply to an inverter input rail.

During a changeover situation, there is relay system for changing from one source to another is needed. The changeover depends on the difference in voltage between the input and output of the system. the voltages between the two power sources are equal and both combine together to power the connected load(s).

In this study, power supply modules (as the primary power supply) and two-48V parallel connected-battery banks (as the secondary power supply) are linked together. This implies that when the DC power is lower than the DC power from battery systems, it will automatically changeover to double-battery bank system. Also once a steady power is maintained and the feedback system is functional, the output voltage of the inverter becomes constant. This will lead to a steady power supply to the rural dwellers and other critical loads in the villages such healthcare centers.

II. EXISTING SYSTEM

The system uninterruptible DC powered boost differential inverter with a sensor-less changeover system was proposed by Eya U, Oti Stephen ejiohor and Ayodejisalau which is maintain constant power supply to load with sensor-less operation.

The systems design was developed using solar panels, bidirectional converter current linked battery banks, and a single-staged DC/AC Converter

This system consists of two power sources which are solar power and battery banks. These two sources are feed to the load whenever load is running. In this system is mainly focused on load. By considering the load variations, incoming power source will vary.

This shows that there is interaction between solar energy, electrical energy, and chemical energy to accomplish a particular purpose of constant DC power supply to an inverter input rail.

The above switching will do through the feedback network which is consists of PID controller. This controller works whenever the load is varies. During a changeover situation, there is no sensor and relay system for changing from one source to another is needed. The changeover depends on the difference in voltage between the solar panels and the battery network system.

III. PROPOSEDMETHODOLOGY

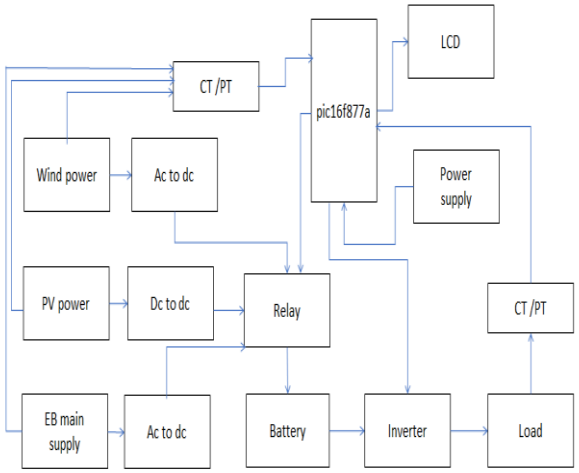

Figure3.1.BlockDiagram

The systems design was developed using multiple power sources which is solar, wind, EB supply and battery banks. And also this system consists of programmed microcontroller which is helps to lead the system as shown in figure3.1.

This proposed concept gives that there is a multiple power sources to accomplish the load. And also this one have a efficiency to satisfy whenever the load varying.

During a changeover situation, there is a sensor and relay system for changing from one source to another is need. The changeover depends on the difference in voltage between the power sources.

Whenever all power sources fails, the battery bank will lead the system which is serially connected with power sources and inverter section.

Also once a steady power is maintained and the feedback system is functional, the output voltage of the inverter becomes constant. The feedback system is consists of PIC microcontroller This will lead to a steady power supply to

the rural dwellers and other critical loads in the villages such healthcare centers.

The hybrid system gives electrical energy to feed the load through the battery banks and inverter. In cases where the current source is lower than another source, another source will deliver power to the load automatically. But when they have the same potential difference, they all feed to load and at that point in time, their currents jointly flow to the load since the load has lower potential.

This means that during the day there will be always constant DC voltage at the DC bus system. The relay is placed before the battery bank, which is helps to make a switching operation in-between the power supply to satisfy the load. Depends upon the PIC microcontroller signal, relay will operate to switch the power supply. Microcontroller takes reference from CT & PT which is connected in input and output.

By reference of CT & PT, It monitors the output AC voltage level across the load. When the AC voltage is less than or more than 230V, it sends a signal to the feedback to stabilize the output voltage.

SOLAR PANEL

A solar cell panel, solar electric panel, photo-voltaic (PV) module or solar panel is an assembly of photo-voltaic cells mounted in a framework for installation. Solar panels use sunlight as a source of energy to generate direct current electricity. A collection of PV modules is called a PV panel, and a system of PV panels is called an array. Arrays of a photovoltaic system supply solar electricity to electrical equipment.

DC to DC CONVERTER

A DC-to-DC converter is an electronic circuit or electromechanical device that converts a source of direct current (DC) from one voltage level to another. It is a type of electric power converter. Power levels range from very low (small batteries) to very high (high-voltage power transmission).

AC to DC CONVERTER

An AC to DC converter is an electronic device that converts alternating current (AC) electricity to direct current (DC). AC voltage is commonly found in homes and businesses and is used to power a variety of devices, such as computers, lights, and appliances. DC voltage is more commonly found in electronic devices, such as batteries. AC to DC converters are used to convert AC voltage to DC voltage in order to power devices that require DC voltage.

RELAY CIRCUIT

A relay driver circuit is a circuit which can drive, or operate, a relay so that it can function appropriately in a circuit. The driven relay can then operate as a switch in the circuit which can open or close, according to the needs of the circuit and its operation.

BATTERY

The proposed charging application requires a deep cycle battery. Deep cycle batteries have larger plates and different chemistry to avoid the corrosive effect of frequently using the full capacity. The solar energy is converted into electrical energy and stored in a lead-acid battery. The ampere-hour is the rated capacity of the battery. There are a few types of lead acid deep cycle batteries: If lead acid batteries are maintained properly, they will function at 80-90% efficiency. To extend the life of the battery and maintain efficiency it is important to maintain a full charge under most condition.

INVERTER

A power inverter, inverter or invertor is a power electronic device or circuitry that changes direct current (DC) to alternating current (AC). The resulting AC frequency obtained depends on the particular device employed. Inverters do the opposite of "converters" which were originally large electromechanical devices converting AC to DC. The input voltage, output voltage and frequency, and overall power handling depend on the design of the specific device or circuitry. The inverter does not produce any power; the power is provided by the DC source.

CT and PT

Current transformer is put in series with the line in which the current is to be measured. They are used to step down the current to such a level so that it can easily be measured by using an ammeter. Generally they are expressed as primary: secondary current ratio for e.g.: A 100:5 amp CT will have primary current of 100 Amp’s and secondary current of 5 Amp’s.

Potential transformers are also known as voltage transformers and they are basically step down transformers with extremely accurate turn’s ratio. Potential transformers

step down the voltage of high magnitude to a lower voltage which can be measured with standard measuring instrument. These transformers have large number of primary turns and smaller number of secondary turns. A potential transformer is typically expressed in primary to secondary voltage ratio. For example, a 600:120 PT would mean the voltage across secondary is 120 volts when primary voltage is 600 volts.

PIC CONTROLLER

PIC is a family of modified Harvard architecture microcontrollers made by Microchip Technology, derived from the PIC1650 originally developed by General Instrument's Microelectronics Division. The name PIC initially referred to "Peripheral Interface Controller" now it is "PIC" only.

PICs are popular with both industrial developers and hobbyists alike due to their low cost, wide availability, large user base, extensive collection of application notes, availability of low cost or free development tools, and serial programming (and re-programming with flash memory) capability.

LIQUID CRYSTAL DISPLAY (LCD)

LCD is a type of display used in digital watches and many portable computers. LCD displays utilize to sheets of polarizing material with a liquid crystal solution between them. An electric current passed through the liquid causes the crystals to align so that light cannot pass through them. LCD technology has advanced very rapidly since its initial inception over a decade ago for use in lap top computers. Technical achievements has resulted in brighter displace, higher resolutions, reduce response times and cheaper manufacturing process

IV. EXPERIMENTALSETUP

This project consists of multiple power sources which are wind, solar and EB supply as shown in figure4.1. EB supply will get from electricity board and it will give an interruption whenever the system will go under maintenance or faults. To accommodate this interruption, this system consists of two other sources. Wind is a renewable energy and it supposed to feed the supply every month in the year.The Photovoltaic (PV) array converts the solar energy from the sun into useful electrical energy to feed the load through the inverter.

Apart from these power sources, the battery banks are using in-between the load and input sources. Whenever all input fails, the battery will feed the supply to load (depends upon the capacity). And the battery banks will charge once the inputs were restored and fed to load.

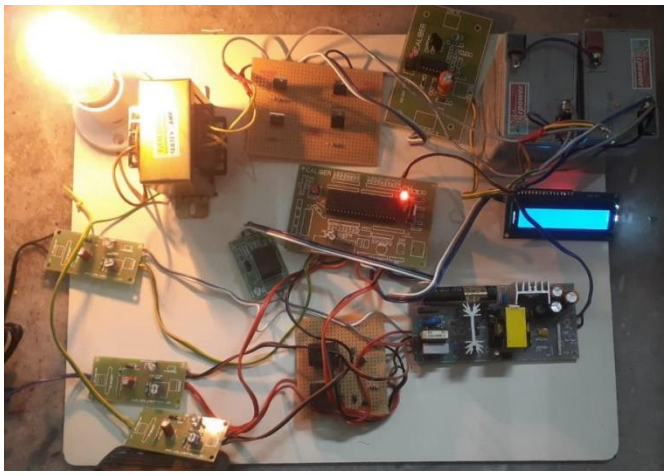

Figure4.1 Picture of Proposed Hardware Kit

In cases where the PV voltage is lower than the battery voltage, the other power sources will deliver power to the load automatically whenever all the power sources fails, the battery will feed to the all over system. But when they have the same potential difference, they both feed the load and at that point in time, their currents jointly flow to the load since the load has lower potential. This means that during the day there will be always constant DC voltage at the DC bus system.

The ct/pt at the output end is used to monitor the output voltage and current of the system as well as used in input side. When the AC voltage is less than or more than 230V rms, it sends a signal to the logic control unit (PID controller) to stabilize the output voltage of the system by adjusting the width of the triggering pulses. Whenever the input is lower than the output, the controller (Fuzzy controller) takes the step to switch the input power source one to another by the way of logical functioning. In words, if the fuzzy controller output is 0, PID controller will not give any control signal to relay. If the fuzzy controller output is 1, PID controller will gives a control signal to relay and relay will act depends upon the needs.

V .SOURCES OF ELECTRICITY

The stated sources of electricity few sources are costly and are applicable to very large scale electricity generations which are shown in table5.1 and table 5.2. An economic usage strategy is required to make the system reliable and cheaper. The following table discusses the priority assigned to different sources of electricity on the basis of

economy and availability.Table5.3 which tells about the comparison of base project and new project.

Table5.1: Ease and economy of implementation of various sources of electricity

Name Of Source.	Availability	Economy in Production	Application
Supply mains	Limited	Moderately costly	Small & large
Solar	Abundant	Cheap	Large
Thermal Power	Limited	Moderate	Large
Wind	Abundant	Cheap	Large
Nuclear	Limited	Costly	Large
Tidal	Abundant	Costly	Large

Table5.2 : Priority of available choices of sources of electricity

Name of the source	Priority(low/med/high)		
	Summer	Rainy	winter
Supply mains	High	High	High
Solar	High	Low	Low
Thermal Power	Med	Med	Med
Wind	Med	Med	Med
Nuclear	Med	High	Med
Tidal	Low	High	Low

Table5.3:Comparisonofproposedwithexistingsystem.

S.No	Parameter	Existing system	Proposed system
1	interruption	With interruption	Without interruption
2	Input source	Single	Multiple
3	Cost	Low	High
4	Controller	PID controller	Fuzzy controller
5	Switching	No device is used	Relay
6	Sensing device	Voltage sensor	CT/PT

VI. RESULTANDDISCUSSION

Result of the proposed system has been Implemented and verified which is shown in figure6.1. Compare to base system, here the multiple power sources were enabled and connected to the load through battery banks. The power sources availabilities are displays through liquid crystal display (LCD).The display will show the output range or parameter once the load is enabled.

Figure6.1 : Status of power sources

The switching operation in-between the power sources are done by relay which is control by PIC controller. Fuzzy controller gives good dynamic response and having special ability to control the parameters. It controls PIC control by the way of logical functioning. By use of this controller, the efficiency of the project was increased.

The discussion about the base system and proposed system is, proposed system is effectively making a switching operation by using of relay and there are no multiple power sources and switching operation in base system. PID controller having demerit to control the parameters and Fuzzy controller having special ability to control the parameter and from this the efficiency of the system will increase. At the of the discussion, the output of the system will protect and run constantly without any interruption by using this method.

VII. CONCLUSION

An uninterruptible power supply with multiple power sources by using fuzzy controller system has been presented, analyzed, simulated, and experimented. The results show that the developed system is efficient compare to base system with high speed dynamic response. Depends upon the application, the requirement of system power will vary. This specification finds application in industries and residential areas and it suits for everywhere where the load must to run in 24/7 without interruption. This project size and costs are vary depends upon the needs and specifications. This project will be implementing or constructing by adding the new power sources and controller aswell.

VIII. FUTURESCOPE

In future, this system plays vital role at the location of emergency and critical load centers. We can extent the solar panels and wind source depends upon our need. This system has more chance to implement in future. Because of we are using renewable sources. The system battery will change whenever the updated version comes. Because of, we can change all the source modules whenever the new system

comes. So that, this system is more adopt for future implementation.

REFERENCES

[1] Candidus u. Eya , ayodejiolalekansalau , stephenejio forotiwas “Uninterruptible DC-powered boost differential inverter with a changeover system” Article in WSEAS Transactions on Circuits and Systems · DOI: 10.37394/23201.2021.20.2 March 2021

[2] Eya, C., Crescent, O., Ukwejeh, J.M“Solar powered five level output voltage of dc-to-ac converter using simplified capacitor voltage controlled scheme” in 10.11.09/PowerAfrica46609.2019.9078670 IEEE Paper.

[3] Andy Howard (2015-08-25). "How to Design DC-to-DC Converters".YouTube.Retrieved 2015-10-02.

[4] Li, D., Notohara, Y., Iwaji, Y., and Kurita, Y.“AC Voltage and Current Sensor less Control Method for Three-Phase PWM Converter” Electrical Engineering in Japan, Vol. 172, No. 4, 2010, pp. 48-57.

[5] Joseph Henry". GeorgiDalakov“The electromechanical relay” Archived from the original on 2012-06-18. Retrieved 2012-06-21.

[6] Ohl, Russell (27 May 1941). "Light-sensitive electric device".Retrieved 7 September 2018.

[7] Charles F. Brush. Danish Wind Industry Association”A Wind Energy Pioneer”Archived from the original on 8 September 2008. Retrieved 28 December 2008.

[8] Gerla, Giangiacomo (2005). "Fuzzy logic programming and fuzzy control".StudiaLogica. 79 (2): 231–254. CiteSeerX 10.1.1.103.1143. doi:10.1007/s11225-005-2977-0. S2CID 14958568.

[9] Lawson, Eric (May 16, 2013). "Microchip Technology Delivers 12 Billionth PIC® Microcontroller to Leading Motor Manufacturer, Nidec Corporation". Microchip press release. Archived from the original on July 21, 2013. Retrieved December 21, 2017.

[10] Stanley H. Horowitz, Arun G. PhadkePower system relaying third edition, John Wiley and Sons, 2008 ISBN 0-470-05712-2

[11] Ton, My; Fortenbery, Brian; Tschudi, William (January 2007). "DC Power for Improved Data Center Efficiency" (PDF). Lawrence Berkeley National Laboratory. Archived from the original (PDF) on 2010-10-08.