ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijareeie.com

Vol. 9, Issue 3, March 2020

An IoT Based Voltage Stability Control Using SFCL for Hybrid Power Generation System

P.Kavikiruthika[1], S.Kalpanadevi[2]

P.G. Student, Department of Embedded System Technologies, Knowledge Institute of Technology, Kakapalayam, Tamil Nadu, India [1]

Assoc. Professor, Department of EEE, Knowledge Institute of Technology, Kakapalayam, Tamil Nadu, India [2]

ABSTRACT: In today's world electricity is being the most needed facility for the existence of human life. Since all the conventional energy resources are depleting day by day hence there is an urge to shift from conventional to non-conventional energy resources and at the same time wind and solar energy are the two clean non-conventional energy sources found to be abundant in nature. This paper proposes a new idea with hybrid sources for improving the AC load voltage stability with resistive Superconducting Fault Current Limiter (SFCL) based H-bridge inverter. Here interleaved multiport DC to DC converter is recommended which connects two DC sources (Solar and Wind) for reduction in cost and power loss. It also ensures galvanic isolation between energy sources, battery and the load. The output from both energy sources is fed to multiport converter for getting fixed DC and from there it is inverted using H-bridge inverter. Using PI controller, sinusoidal PWM control pulses are generated and fed to multiport DC-DC converter and inverter. Output of inverter is three phase sinusoidal AC voltage which is fed to the load via resistive SFCL for limiting the severity of fault current and to improve voltage stability hence reliability of power system is ensured. In addition, voltage stability of hybrid energy system is monitored using IOT for better operation. Information about fault current, fault voltage and physical fault existing in solar panel (LDR Sensor) and wind turbine (Vibration sensor) is studied and transmitted to ESP8266 Wi-Fi module with a provision to maintain the voltage stability wirelessly. The proposed system helps the user to control the sources of energy remotely and manually using smart phone or personal computer and the system proposed is cheaper, flexible and very efficient in operation. The simulation of the proposed method is done in MATLAB simulation platform and it proves better voltage stability can be achieved using resistive SFCL.

KEYWORDS: Hybrid energy system, interleaved multiport DC-DC converter, SFCL, Resistive superconducting fault current limiter, IOT, H-bridge inverter, LDR, Vibration sensor, Wi-Fi, MATLAB.

I. INTRODUCTION

The world's power demand is increasing day by day and at the same time traditional energy sources like coal, oil, gas and hydro are depleting and causing harm to the nature[9]. Natural energy sources like Sun, Wind, and Tides are abundant in nature and they can also be replenished naturally. So, solar energy source is combined with wind to yield maximum power[7]. The output of the solar panel and wind source is given to the Multi port Converter through controller. Multiport converter can be used to interface multiple power sources and storage devices. From the multiport converter, we can charge the battery with maximum efficiency[2]. Increase in system capacity leads to higher fault occurrence that can induce severe damages in electrical power system[4]. For example, the high value of the short circuit current can damage the insulation strength of electrical devices, synchronous generators, protective relays, lines transmission, and loads. Recently, the development of superconducting fault current limiters (SFCL) solves the fault current problems. Due to the fast transition from a low to high impedance, superconducting devices can limit, the value of any fault current in a very short time. The SFCL in a power system can increase the stability of the system and distributed energy quality by choosing Optimal location of the SFCL in the Electric Power Grid.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijareeie.com

Vol. 9, Issue 3, March 2020

In this proposed method the SFCL is connected between the inverter and AC load, the Output of inverter is three phase sinusoidal AC voltage which is fed to the load via resistive SFCL for limiting the severity of fault current and to improve voltage stability hence reliability of power system is ensured. The toolbox Simulation Power Systems of MATLAB software is used to carry out simulations studies.

The advantage of the proposed method is that the selected location of the SFCL reduces the fault current and maintain the voltage stability to the load. In addition Voltage Stability is monitored using IOT. IOT (Internet of Things) is the internetworking of physical device embedded with sources such as sensors, software, network and electronic connectivity that enable objects to collect and exchange data. IOT is used to switch the power supply between wind energy and solar energy of two sources are secured through website when the grid supply is off. The proposed prototype is studied to control the switching between these two sources of energy. C.Nagarajan et al [4,12] studies this design is not only an affordable and simple system but also a reliable, efficient and cost effective one[10]. With the advancement in technology, provide sensors, metering, transmission, Distribution, and flexibility to consumers of electricity, it can also be possible to control the sources of energy of a house by this prototype.

II. EXISTING SYSTEM

In this existing system fig.1.shows that, only sources from the solar panel is used, when the AC power is not available we can charge the device only using the power generated by the solar panel. The output of the DC source is provided with MPPT algorithm and it is connected to the inverter in which the fault may occur under certain condition which is not proposed to reality. To overcome this, the transformer is applied to the inverter. But the battery cannot be charged simultaneous from both the sources. The existing system comprises of the following components are PV array, DC-DC converter, MPPT, Inverter, Transformer and distribution Panel. The demerits of existing system is there is no battery for storing the charged energy, efficiency is low, complex mechanism, If any one source is used, solar energy may not be available at all the time.

2.1BLOCK DIAGRAM OF EXISTING SYSTEM:

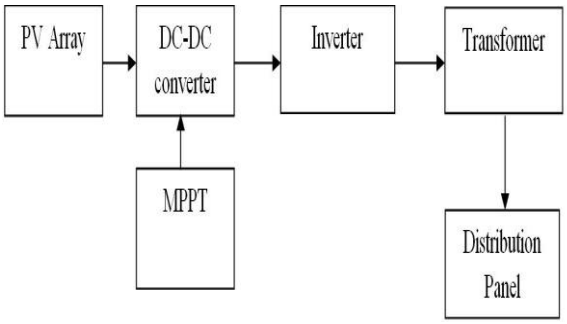

Fig.1.Block diagram of existing system

III. PROPOSED SYSTEM DESCRIPTION

The proposed system is the combination of two sources like solar energy and wind energy. Compared to any other non-conventional energy sources Solar and wind have greater availability in all areas. The energy from the sun is collected using the solar panel. Wind Energy is extracted from wind. Both are renewable energy sources.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijareeie.com

Vol. 9, Issue 3, March 2020

3.1 BLOCK DIAGRAM OF THE PROPOSED SYSTEM

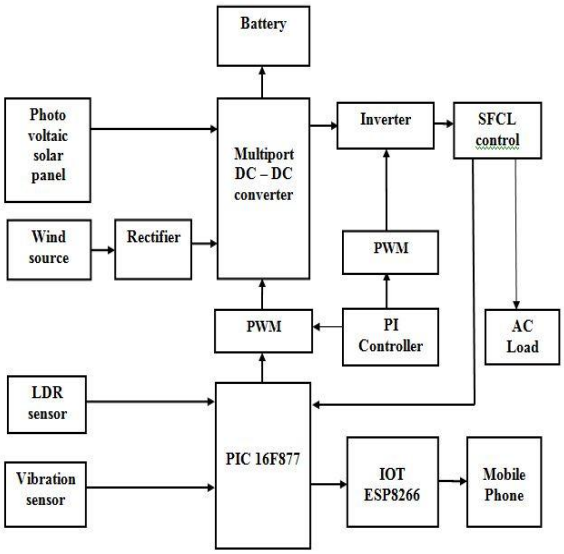

Fig.2. Proposed Block Diagram

Fig.2. shows that the power from the two sources is converted to DC and its output is fed to the multiport converter. Using multiport converter, battery can be charged simultaneously from two input sources. By three modes of operation in the converter, inductors and capacitors are charged and discharged accordingly. The output from the multiport converter is given to the inverter. Fault may occur in the inverter under certain conditions which may lead to unbalanced voltage. To overcome this, a superconducting fault current limiter (SFCL)combined with its optimal resistive value is used. The presence of this additional resistance improves the power system stability in case of short-circuit and the position of the fault. The SFCL is not used to limit the Fault current but also to improve the stability of the power system. This improves the system stability during a fault. Finally, the stable power is provided to the electric power grid. In addition ESP8266 module is used to transmit and receive the electrical data wirelessly,which is collected from internet through designed website and the control system. The ESP8266 transmitter is interfaced with various sensing devices and reliable data reception at a receiver side of ESP8266 module. The ESP8266 receiver has been interfaced through router which is connected to the internet. The Load can be monitored and controlled remotely. The controlling operation is performed in two ways. Those are manual controlling and remote controlling.

• Manual control: An on/off and source change switch is provided directly to the power system. In this mode user can manually operates the load without following remote control. Manual control is very adaptive.

• Remote Control: In remote control user can interact with the load remotely with smart phone or personal computer using secured internet web connection. User can control and operates the system when he is away from the home. This feature also reduces manual efforts and time by controlling the system from one place.

The block diagram of the proposed system comprises of following components: Photo Voltaic Solar Panel, Wind Source, Rectifier, Multi-Port DC-DC converter, Inverter, PI controller, SFCL, ESP8266, AC load.

3.2 SOLAR PANEL

Solar panel (photovoltaic module or photovoltaic panel) is a packaged, interconnected assembly of solar cells, also known as photovoltaic cells. The solar panel can be used as a component of a larger photovoltaic system to generate and supply electricity in commercial and residential application Because a single solar panel can produce only a limited amount of power, many installations contain several panels.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijareeie.com

Vol. 9, Issue 3, March 2020

3.3 WIND SOURCE

Windmill is a machine that converts the wind energy into rotational energy with support of vanes called blades. They function by using the kinetic energy of the wind, which pushes the blades of the turbine and spins a motor that transform the kinetic energy into electrical energy for consumer use. They supply clean and renewable energy for both home and office.

3.4 MODES OF OPERATION IN THE MULTIPORT CONVERTER

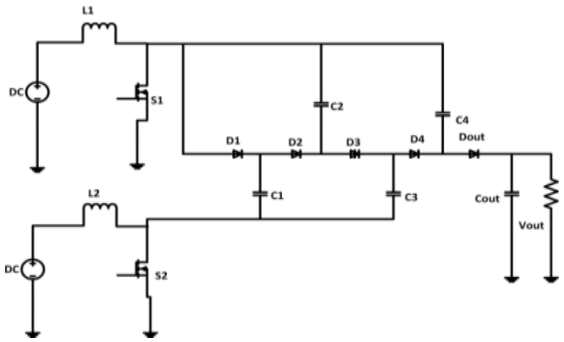

Fig.3 Proposed Multiport Converter

Mode 1:

In the Mode 1 both the switches are on s1 and s2 are charged from their input source.

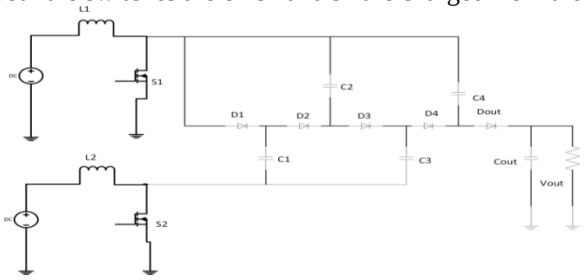

Fig.4. Mode 1 of Multiport Converter

Mode 2:

In the mode 2, s1 is in off state and s2 alone is on. During this time the Odd numbered diodes D1,D3 and C out are forward biased and all the capacitors charges.

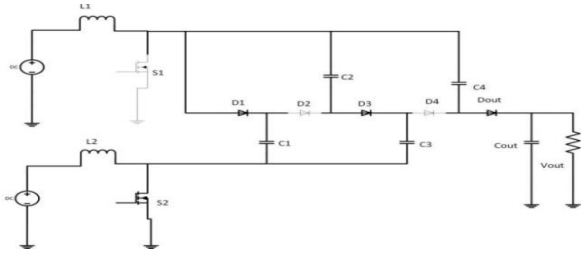

Fig.5 Mode 2 of Multiport Converter

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijareeie.com

Vol. 9, Issue 3, March 2020

Mode 3:

In the mode 3,the diodes D1,D3,Dout are reversed biased. They do discharging now. The diodes D2 and D4 are now forward biased

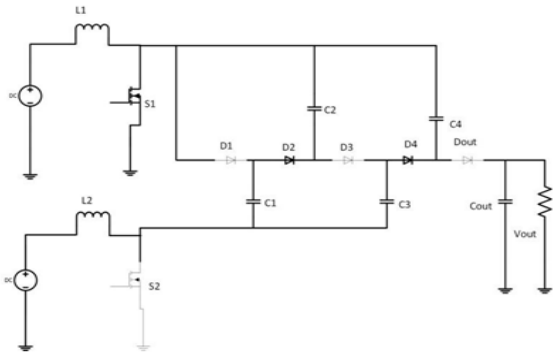

Fig.6. Mode 3 of Multiport Converter

3.5 SFCL APPLIED TO INVERTER

The operation of an SFCL is based on the transition of the superconducting state to normal state by exceeding the current I of the material. This transition must be done in a very short time, generally, to limit the first current peak to a threshold value not exceeding the rated current, below the short-circuit current without limitation. The SFCL is placed with a circuit breaker in series. When the fault occurs, the current increases up to reach the threshold of transition from super conducting wire. This transition causes the development of resistance that limits or triggers the current limit. The time between threshold crossing and the limitation is small (a few microseconds). The circuit breaker isolates the line as soon as possible after the beginning of the limitation. The SFCL is not used to limit the fault current but also to improve the stability of the power system.

3.6 ESP8266 WI-FI MODULE

The ESP8266 is a low-cost Wi-Fi microchip, with a full TCP/IP stack and microcontroller capability, This small module allows microcontrollers to connect to a Wi-Fi network and make simple TCP/IP connections using Hayes-style commands The ESP8285 is an ESP8266 with 1 MiB of built-in flash, allowing the building of single-chip devices capable of connecting to Wi-Fi.

Fig.7. ESP8266 WI-FI

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijareeie.com

Vol. 9, Issue 3, March 2020

IV. SOFTWARE DESCRIPTION

4.1 MATLAB

MATLAB is a high-performance language for technical computing. It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation.

Typical uses include:

Math and computation

Algorithm development

Modelling, simulation, and prototyping

Data analysis, exploration, and visualization

Scientific and engineering graphics

Application development, including Graphical User Interface building

4.2 MPLAB microchip

MPLAB is a proprietary freeware integrated development environment for the development of embedded applications on PIC and dsPICmicrocontrollers, and is developed by Microchip Technology. MPLAB X is the latest edition of MPLAB, and is developed on the NetBeans platform.

4.3 Android Studio

Android studio is the official integrated development environment for Google's Android operating system, built on JetBrains' IntelliJ IDEA software and designed specifically for Android development. It is available for download onWindows, macOS and Linux based operating systems.

V. RESULT AND DISCUSSION

5.1 MATLAB SIMULAION DIAGRAM OF HYBRID RENEWABLE ENERGY SOURCE AND POWER SYSTEM STABILITY USING SFCL

Thus the proposed system helps in achieving the stability of the power system using SFCL based H-bridge inverter. The interleaved multiport DC to DC converter is recommended which connects two DC sources (Solar and Wind) for getting fixed DC voltage. Output of inverter is sinusoidal AC voltage which is fed to the load via resistive SFCL for limiting the severity of fault current and to improve voltage stability in power system as described in simulation Fig.8.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijareeie.com

Vol. 9, Issue 3, March 2020

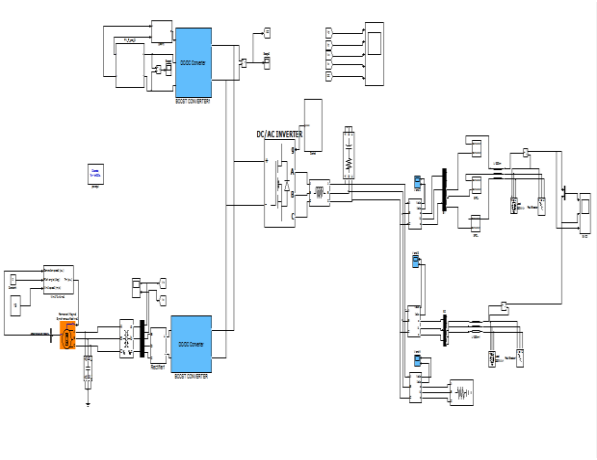

Fig.8. Simulation diagram of Hybrid Renewable Energy Source and Power System Stability using SFCL
The respective simulation results are shown below

5.2 SOLAR VOLTAGE AND CURRENT:

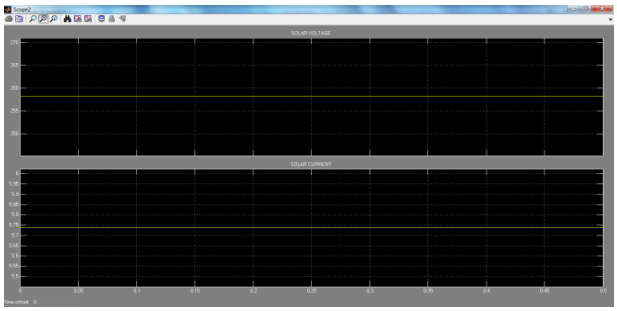

Fig.9. Solar Voltage and Current

Fig.9. shows that the voltage and current waveform obtained from the solar panel.

5.3 WIND VOLTAGE AND CURRENT:

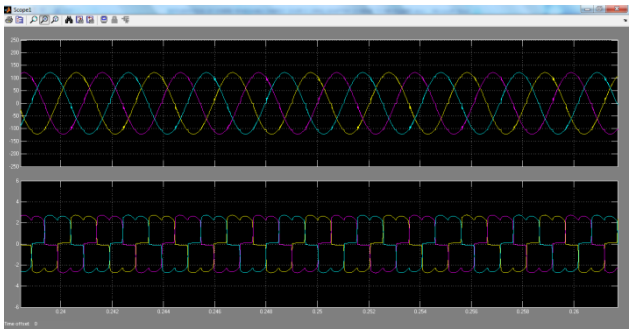

Fig.10. Wind Voltage and Current

Fig.10. shows that the voltage and current waveform received from the wind source.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijareeie.com

Vol. 9, Issue 3, March 2020

5.4 DC CONVERTER OUTPUT:

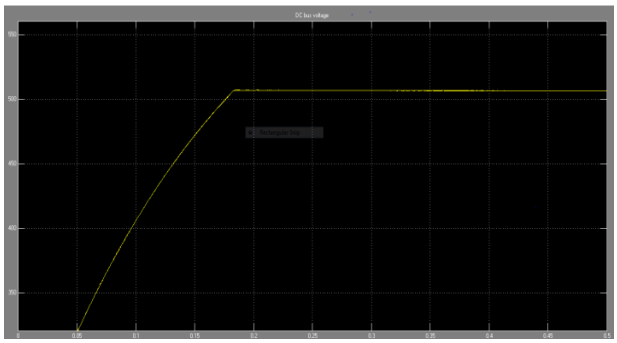

Fig.11. DC Converter Output

Fig.11. shows that the output from the solar panel and wind source is converted to interleaved multiport DC-DC converter and it gives fixed voltage value from both the sources.

5.5 AC INVERTER OUTPUT:

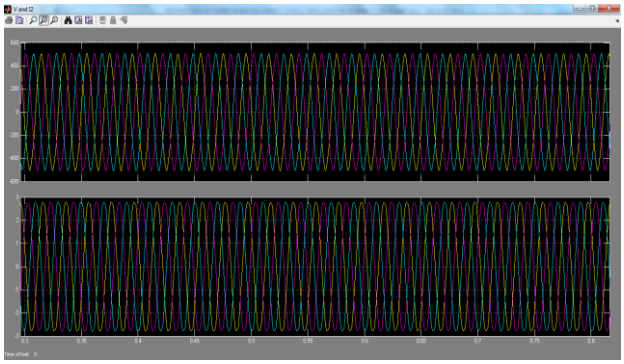

Fig.12. AC Inverter Output

Fig.12. shows that the converted dc output voltage is inverted using H-bridge inverter and it gives sinusoidal AC output voltage waveform.

5.6 WITH AND WITHOUT SFCL VOLTAGE AND CURRENT:

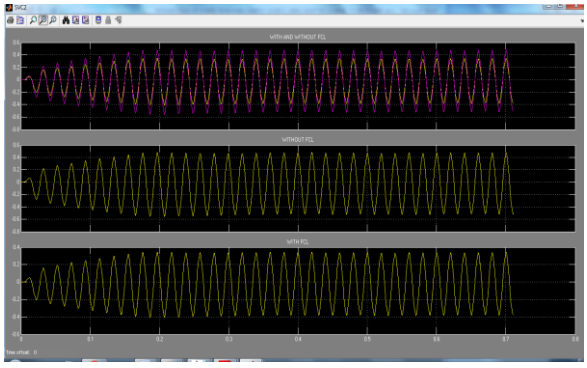

Fig.13. With and Without SFCL Voltage and Current

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijareeie.com

Vol. 9, Issue 3, March 2020

Output of inverter is three phase sinusoidal AC voltage which is fed to the load via resistive SFCL for limiting the severity of fault current and to improve voltage stability in which the Fig.13. shows the differentiation of using with and without SFCL method.

VI. CONCLUSION AND FUTURE SCOPE

6.1 CONCLUSION

The proposed work discussed about SFCL method based inverter to provide better voltage regulation under hybrid power generation systems. This can also be capable to operate under wide range of operation modes and conditions. Simulation output clearly reveals that fault can be rectified in a better way using SFCL method as compared with conventional methods of fault recovery in inverters. By installing this system, we could at least reduce the grid dependency.

6.2 FUTURE SCOPE

The future scope is controlled by the user is able to receive detailed information of facility at site, efficient maintenance for regular check-up and failure could be performed conveniently. It is the most reliable and cost efficient. We encourage the scientific community to consider this technology along with others when contemplating efforts and resources for renewable energy.

REFERENCES

[1] Ahmed Saidi and BenachaibaChellali, Simulation Control of Solar Wind Hybrid Renewable Power System, 978-1-5090-3960-9/17/$31.00 ©2017 IEEE.
[2] Azfarul Islam, AsifAzam, SarafWamiaProtity , ShoilieChakma and AvijitDas , Grid Connected Hybrid Solar System with MPPT Charge Controller, 19-21 December 2016, AISSMS, Pune, India.
[3] Bharat Raj Singh and Bal Krishna Dubey, Solar Wind Hybrid Power Generation System,e-ISSN: 2395-0056, p-ISSN: 2395-0072International Research Journal of Engineering and Technology (IRJET) Volume: 05 Issue: 01 | Jan-2018.
[4] C.Nagarajan and M.Madheswaran - 'Stability Analysis of Series Parallel Resonant Converter with Fuzzy Logic Controller Using State Space Techniques'- Electric Power Components and Systems, Vol.39 (8), pp.780-793, May 2011
[5] MiladSamady Shadlu , Fault Detection and Diagnosis in Voltage Source Inverters Using Principle Component Analysis, IEEE 4 International conference on Knowledge based Engineering and Innovation.(KBEI) DEC- 22 ,2017.
[6] Gutierrez-Villalobos Jose M, Mora-Vazquez Julio C and Martínez-Hernández Moises. A , Hybrid Solar Wind Power Monitoring and Control System, 978-1-5386-7018-7/18/$31.00 ©2018 IEEE.
[7] Liga de GitanjaliVasant and Prof. Dr. Pawar V. R, Solar Wind Hybrid Energy System Using MPPT, 978-1-5386-2745-7/17/$31.00 ©2017 IEEE.
[8] Mergu Chandramouly and Dr. A. Raghuram, Introduction to Solar Wind Hybrid Energy, ISSN (Online) 2395-2717,International Journal of Engineering Research in Electrical and Electronic Engineering (IJEREEE) Volume 3, Issue 12, December 2017.
[9] QaisH.Jeflawi, Abadal-Salam T. Hussain, F. Malik, Israa A. Dahham ,Syed,Idris Syed Hassan, Hybrid Wind Solar Controller System, ISSN (online): 2348 – 7550, International Journal of Advanced Technology in Engineering and Science Volume No.02, Issue No. 06, June 2014.
[10] Rajkumar yadev and Mr.Mayank Sharma, Hybrid power generation system using solar- wind energy:Review, International Journal of Trend in Scientific Research and Development (IJTSRD) ISSN: 2456-6470 (IJTSRD) Volume 2, Issue 3, Mar-Apr 2018.
[11] Ravikumar.S and Dr. H. Vennila, Hybrid wind solar system for efficient power generation, 978-1-5090-5686-6/17/$31.00 ©2017 IEEE.
[12] C. Nagarajan, M.Madheswaran and D.Ramasubramanian- 'Development of DSP based Robust Control Method for General Resonant Converter Topologies using Transfer Function Model'- Acta Electrotechnica et Informatica Journal , Vol.13 (2), pp.18-31,April-June.2013.