Renewable Energy Integration with Plug-In Electric Vehicles and Charging Stations

Shivashish A. Nemmaniwar
Department of Electrical Engineering
RIT, Urun Islampur
Sangli, India
snemmaniwar3@gmail.com

Krishnraj D. Patil
Department of Electrical Engineering
RIT, Urun Islampur
Sangli, India
krishnarajpatil9797@gmail.com

Sachin P. Mali
Department of Electrical Engineering
RIT, Urun Islampur
Sangli, India
malisachin280499@gmail.com

Akshay S. Bhojugade
Department of Electrical Engineering
RIT, Urun Islampur
Sangli, India
akshatybhojugade9494@gmail.com

Atul Jaysing Patil
Department of Electrical Engineering
RIT, Urun Islampur
Sangli, India
atul2322nith@gmail.com

Megharani Dharme
Department of Electrical Engineering
NIT, Hamirpur
Hamirpur, India
megha2322nith@gmail.com

***Abstract* - The development of integrated solar storage and charging power stations has become a major challenge in new energy development. This work considers the implications of insufficient power supply, effective charging time, load uncertainty, and user evaluation during charging station operation, and proposes a safety evaluation index system based on fuzzy comprehensive evaluation theory. To avoid overly small weight values of evaluation elements, a two-layer evaluation model is utilised for fuzzy comprehensive assessment to ensure the accuracy of the results. Finally, anexample is given to demonstrate the model's usefulness. Two sources are used in the Designed system. Solar photovoltaic panels are one of them, and they are called renewable sources. When implemented, this technology provides increased durability, reliability, and high efficiency from renewable energy sources.**

Keywords – Integrated Solar Storage, Charging Power Station, Fuzzy Comprehensive evaluation.

I. INTRODUCTION

Robert Anderson, a Scotsman, is credited with constructing the first electric vehicle between 1832 and 1839. Electric automobiles are not a brand-new idea. Around the turn of the century, there were roughly twice as many electric cars on the road as petrol/diesel cars [1]. Electric cars did not become obsolete until the 1920s. This was due to the fact that electric vehicles had a limited top speed and range. In 1912, the electric starting motor for gasoline cars was devised, overcoming one of gasoline vehicles' major drawbacks: the necessity to start the car with a hand crank [2]. What are electric automobiles, exactly? This is a frequently asked question. This is a common question. This can be charged withconventional household energy as well as at a range of private and public electric charging stations [1-15].

There are two types of electric vehicles. (A) Vehicles that are entirely electric— A fully electric vehicle's main components are a rechargeable battery, a controller, and an electric motor. First, the battery is charged. The controller then converts the DC to AC electricity so that the motor can use it. The motor converts electrical energy into mechanical energy [12-19].

Hybrid automobiles feature the same technology as electric cars, but they also have a small gasoline engine that acts as a generator. At cruising speed, the car is powered by the batteries, which provide additional power while accelerating. Batteries have the capability of self-recharging. When the vehicle slows or comes to a complete halt. A car that uses less gasoline and has a reduced environmental impact is referred to as a "hybrid." The clutch, transmission, and even the exhaust pipe has all been removed from this electric vehicle. Traditional gasoline is faster and provides a much smoother ride. Vehicles have a history of being driven [16-35].

The current state of the electric vehicle market (global) - The market opportunity has grown significantly over time as more governments around the world look for ways to profit from the current EV revolution. More than 10 million electric vehicles will be on the road around the world by 2020, with battery electric vehicles driving the trend [3]. These are technological breakthroughs in the realm of electric light- duty vehicles [20-29].

As a result, we have a problem with EV charging infrastructure that is inconsistent. Factors such as the growthof the electric vehicle industry and variances in charging loads have highlighted the need for standardization of electric car charging stations. Level 1 charging stations use 120 voltsAC, whereas level 2 charging stations use 208/240 volts AC for rapid charging at 480 volts AC. TheIndian government has mandated the installation of both CHAdeMO and CCS methods [4] since India has yet to attain standardization in rapid charging procedures. The lackof standardization among countries may have an impact on charging Station installation and stifle the market for electriccar charging stations [12-25].

We've seen exponential growth in electric vehicles in response to growing air pollution caused by global warming caused by motor vehicle exhaust emissions, and the inconsistency of faulty charging infrastructure has been increasingly apparent [5]. A single charger can only charge certain types of cars. To overcome these challenges, we're working on a project called "Integration of Renewable Energy with Plug-In Electric Vehicles and Charging Stations" that makes the most efficient use of resources whilestaying true to the Unit promise. The proposed technique's efficacy will be verified using MATLAB simulation data. Wereduce both the amount of fossil fuels we consume and the cost of those fuels [1-8] [25-29].

978-1-6654-7512-9/23/$31.00 ©2023 IEEE

2023 11th International Conference on Internet of Everything, Microwave Engineering, Communication and Networks (IEMECON) | 978-1-6654-7512-9/23/$31.00 ©2023 IEEE | DOI: 10.1109/IEMECON56962.2023.10092305

II. Proposed Method

Solar panels convert solar energy into DC voltage. The MPPT charge controller received the electricity generated as a result of this. The MPPT is used to control or purify the voltage generated and to provide an appropriate 12 V supply. The Auto changeover circuit is powered by a 12 V source. MSEB's energy unit is a standard energy source. The transformer receives the output of this energy source. Transformer for Step-Down Step down the 230V MSEB unit voltage to 12V AC supply and feed it to the rectifier circuit. A rectifier is a device that converts AC to DC voltage. The Auto Changeover Unit receives this DC 12V output. A step-down transformer is used to convert electricity from 230V to 12V in this example. The rectifier circuit is fed 12V AC as an input. The circuit of a rectifier converts AC to DC. An electronic filter, which could be a capacitor or a resistor, smooths the rectifier's output. S2 is the output of the rectifier to the auto-changeover circuit. That is, if S1 is not capable, the output from S2 is used instead. In some circumstances, we employ an auto changeover device to switch from a solar unit to an MSEB unit.

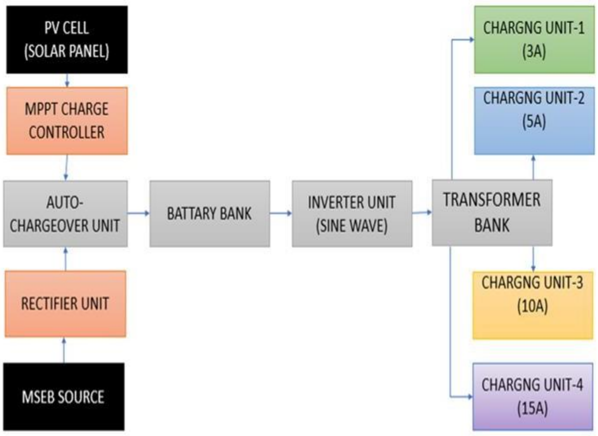

Fig.1 Block Diagram of Proposed System

When the mseb and solar units are not accessible, battery banks are used for energy storage or to provide electricity. Controlling, programming, and providing appropriate power are all done via output circuitry, which also serves as a display unit. We linked each circuit to a step-up transformer rated at 3A, 5A, 10A, and 15A, each with a 12V supply, before to the output circuitry. We employ four different circuits.

How renewable energy is integrated into a plug-in electric vehicle charging station is depicted in the flow chart above. The battery is charged using the renewable source approach when sunshine is available; if sunlight is not available, the battery is charged using the conventional source, which in system is MSEB.

In the first case, when sunlight is present, the photovoltaic effect produces DC energy, which is passed to the MPPT charge controller, whose output is 12 volts to supply to the battery. The MPPT charge controller circuit's main function is to extract the maximum available power from the solar panel and produce to charge. the battery through an automatic switchover circuit MPPT is a system that checks the output of solar panels and compares it to the voltage of the battery, then determines the best power that the solar panel can provide to charge the battery while also protecting the battery from overcharging and monitoring reverse current flow.

Second case 2 - In this scenario, power is drawn from a 230v ac MSEB unit, which is then stepped down to 12v and passed through a rectifier unit. Rectifier converts 12 volts AC to 12 volts DC and supplies power to the battery. An auto changeover circuit is utilised to switch between renewable and conventional power sources. Battery is used in the system when both renewable and conventional sources are unavailable. Battery supplies 12-volt dc to invertor circuit, which contains step up transformer that converts 12-volt dc to 230-volt ac and provides to output circuit inverter circuit is used because when charging process is on, battery storageis reduced, so cannot take 12-volt constant supply at the customer end. The output circuit has a rated voltage and current step-down transformer that converts 230v ac to 12v ac and feeds it to the rectifier and control circuit, which gives the rated voltage and current at the system's output.

III. Flow Chart

A flow chart of proposed system is mentioned below. Here smart approach is used which is better than previous design, Also this system enhances performance.

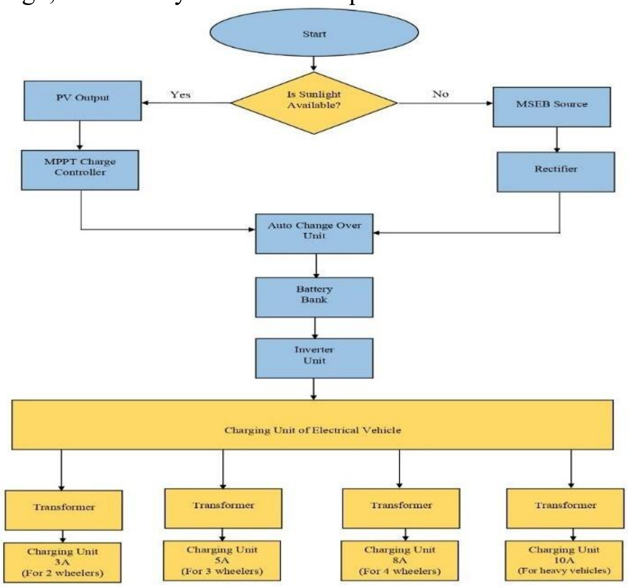

Fig.2 Flow Chart of Proposed System

A) RECTIFIER CIRCUIT:

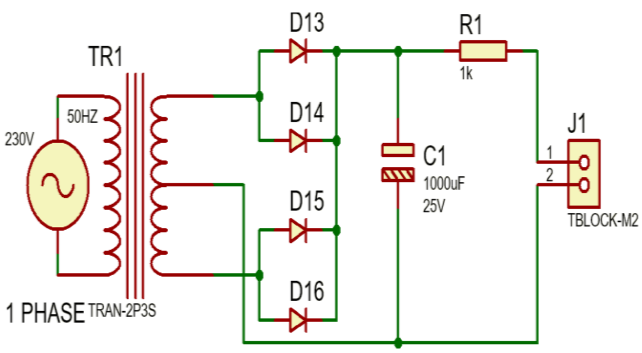

Fig.3 Rectifier Circuit Diagram

Step Down Transformer is linked in the above figure 3 to convert voltage from 230V to 12V. An electronic filter,which could be a capacitor or a resistor, smooths the rectifier's output. Bridge rectifiers are utilised in bigapplications where high AC to low DC conversion is required. S2 is the output of the rectifier to the auto changeover circuit. That is, if S1 is not capable, the output from S2 is used instead.

B) AUTO CHANGEOVER CIRCUIT:

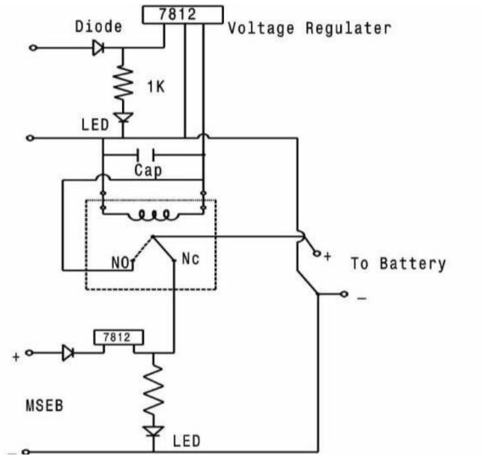

Fig.4 The above diagram represents Auto Changeover Circuit

10A dual source 18-20 I/P auto changeover circuit the transfer switch that switches between two electrical sources S1 and S2 is known as a changeover. We have two sources: S1 is from the sun, and S2 is from the MSEB.

Initially, will use S1 (solar energy) for this project. because it is a renewable energy source that is less expensive than S2. When solar energy is reduced (evening/night time, rainy/cloudy season), the relay is disengaged for a fraction of a second and the electric appliances are connected to S2. As a result, the battery will be charged from S2 at that time.

IV. SIMULATION

A) MPPT CHARGE CONTROLLER:

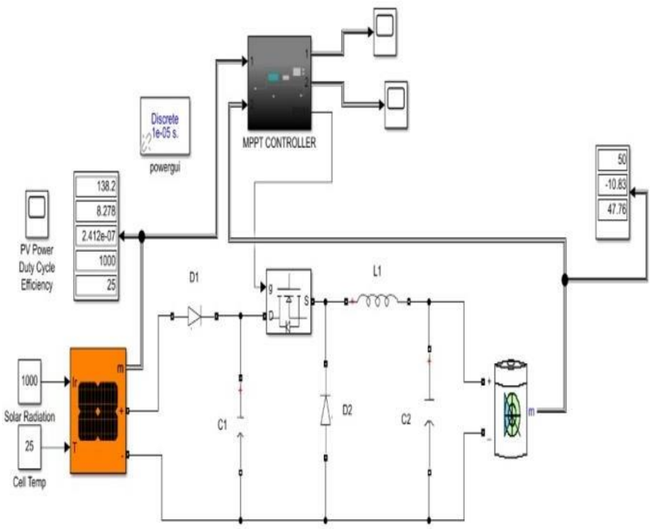

Fig.5 The above figure represents the Simulation of MPPT.

The maximum power point controller is used to ensure that the PV module in the system produces the highest possible output power. Because the precision of PWM is around 70% and the accuracy of MPPT is around 90%, the maximum power point controller is chosen over pulse width modulation (PWM). The constant voltage approach is used, and a buck-boost converter is included in the circuit design. MPPT takes the solar panel's output and converts it to 12V DC for the auto changeover. When a supply interface or interruption occurs, the MPPT shuts down the flow to the auto changeover circuit.

The boost converter will be utilised in conjunction with a Maximum Power Point Tracking control system to achieve the project's principal goal.

B) 3A CIRCUIT:

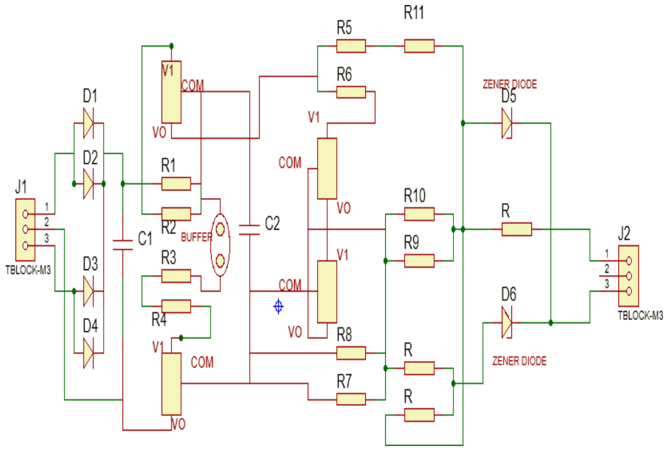

Fig.6 Circuit Diagram for 10-amp output current

System provided 12V, 3A power to this circuit via a step-down transformer that is paralleled with other charging circuits.

We didn't utilize a microcontroller in this circuit; thus, it's called a transistor-based circuit.

A systems designed a center tapped full wave rectifier to convert AC to DC, and this converted dc supply was given tothe filter capacitor to filter or give proper 12V supply, as wellas other voltage regulators used to regulate voltage. By usingthis circuit, get proper 12V, 3A output to charge electric vehicle batteries with a charging current rating of 3A.

C) 10A Charging Circuit:

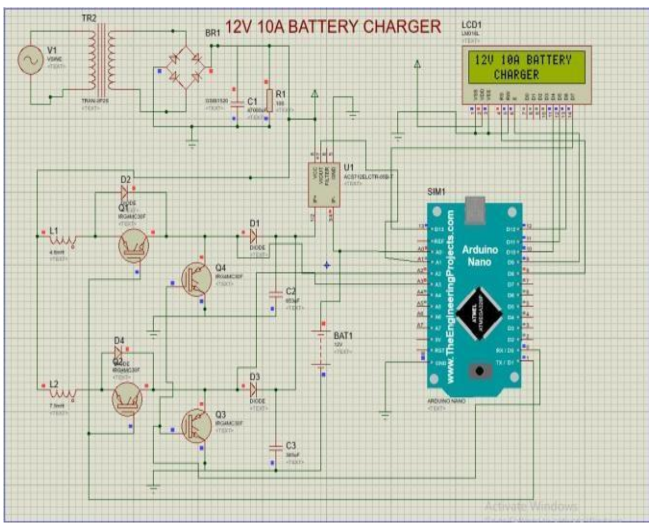

Fig.7 Circuit Diagram for 10-amp output current

This circuit is an operating circuit for a 10-amp output current. It features a rectifier and is controlled by a microcontroller. It is used to charge four-wheeler batteries.

In this circuit, have a 230v ac supply that is routed through a stepdown transformer that outputs 18v ac, and then this supply is routed via a full bridge diode rectifier that converts 18v ac to 18v dc. A 47000uf capacitor is employed as a filter capacitor, with a 100-ohm resistor.

This circuit is a buck boost circuit where Q1 and Q2 carry the buck operation, the bypass diode D2 and D4 are connected as bypass diode, Q4 and Q3 carry the boost operation, and D1 and D3 diode are used for bidirectional flow. Capacitor C2 and C3 are connected as filter capacitors.

The output of the diodes from Q1 and Q4 is connected to the output of the current transformer, which is used to read the output current as 10A. The connections of the current transformer are given to the Nano Arduino, which are A0 -Input voltage (Vin), A1 -Output voltage (Vout), A2-Diode 1 (D1), and A3 - Diode 3 (D3) (D3). The circuit employs the constant voltage approach.

The digital display receives the digital outputs D12, D11, D10, D9, and D8. The size of the digital display used is 12*6. This circuit's output is 12V and 10A. This circuit features intelligent control that allows it to detect current and voltage.

D) 10A CIRCUIT:

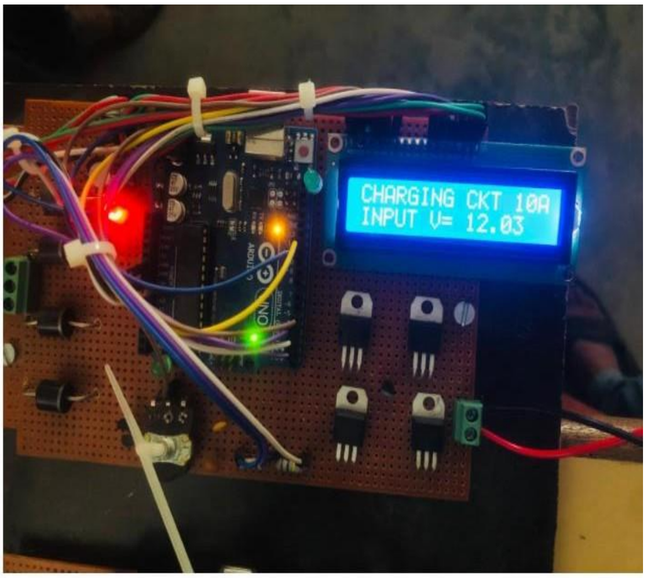

Fig.8 Circuit Diagram for 10A charging circuit

The 10A charging circuit is shown in the diagram above. This circuit is powered by a 12V, 10A supply from a step-down transformer connected to anothercharging circuit. Because utilised Arduino UNO circuit with built-in ATMEGA328P-PU IC microcontroller to convert dc supply delivered to the filter capacitor to filter or give suitable 12V supply, and other voltage regulators were used to regulate voltage, this circuit is microcontroller-based. The Arduino uno controlled 12V battery charger circuit's software code was created in the Arduino programming language and compiled with the Arduino IDE.

V. HARDWARE SETUP:

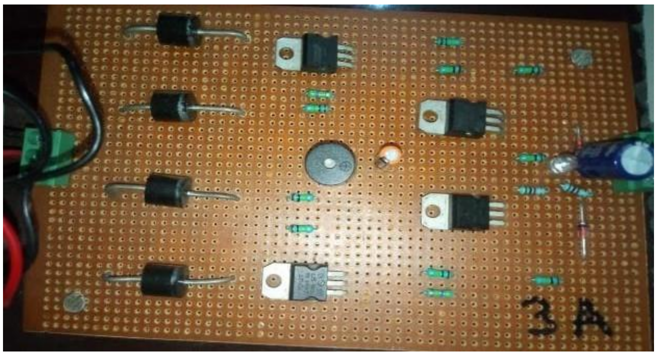

Fig.9 Hardware Setup of Proposed System

Circuit for charging at 3 amps. This circuit is powered by a 12V, 3A supply from a step-down transformer connected to another charging circuit. We didn't utilize a microcontroller in this circuit; thus, it's called a transistor-based circuit.

Converting AC to DC designed a center-tapped full wave rectifier that converted dc power into 12V and additional voltage regulators to regulate voltage.

With this circuit, have a proper 12V, 3A output to chargean electric vehicle battery with a 3A charging current rating.

VI. RESULT AND DISCUSSION

I. VOLTAGE WAVEFORM:

Voltage waveform is constant at all output charging circuits with variable current circuits (i.e., 3A, 5A, 10A, 15 A)

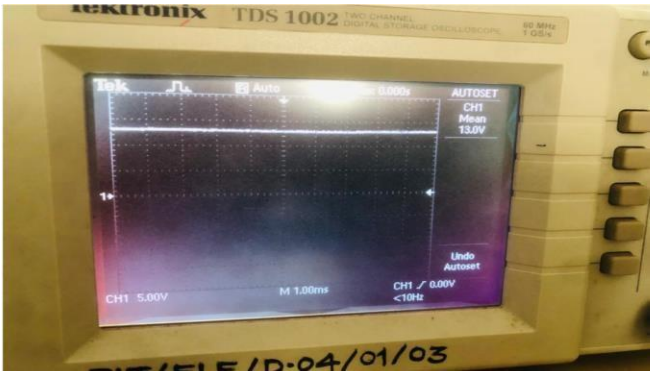

Fig.10 Voltage Waveform at 3A,5A,10A and 15A

below is common for all the output circuitry. The method is used is known as constant voltage variable The above figure shows the voltage waveform obtained from the Digital Storage Oscilloscope (DSO).

This waveform is a pure DC waveform acquired by connecting a Digital Storage Oscilloscope (DSO) to the system's 10 A circuitry output load. This graph depictsthe present method. The waveforms for 3A, 5A, 10A, and 15A are recorded. The digital storage oscilloscope is a devicethat allows you to save a digital waveform or a digital duplicate of a waveform. It allows us to store the signal or waveform in digital format, as well as perform digital signal processing techniques on the signal, in digital memory. The maximum value measured on a digital signal oscilloscope is determined by the scope's sampling rate and thenature of the converter. Digital Storage Oscilloscope (DSO) traces are brilliant, well-defined, and appear in seconds.

II. CURRENT RATINGS:

A) 5A CIRCUIT:

It connected a DC ammeter to the load in the 5A circuit. To determine the flow of load current. The current going to the load is around 5A, as shown in the diagram. It used 5 capacitors, 4 regulators, and 4 resistors in the 5A circuit. This is a thyristor control circuit that produces a 5A DC current output.

Fig.11 5A Circuit Setup

B) 10A CIRCUIT:

A connected a DC ammeter to the load in the 10A circuit. To determine the flow of load current. The current going to the load is around 10A, as shown in the diagram. The 10A circuit is a microcontroller-based design that includes a UNO Arduino for regulating and delivering 10A DC current at the output. Bridge rectifier circuitry is also included in the circuit. In this circuit, there is also a display.

CONCLUSION

According to this report, electric vehicles and renewable energy sources are promising answers to rising greenhouse gas emissions. The benefit of this paradigm cannot be seen in constant battery charging, as every EV vehicle would be required to charge (i.e., there should be no overcharging). Because the fuel cost is $0 due to the use of renewable energy, cost minimization should be considered.

Because India has such a large road network, it needs to establish as many charging stations as possible to increase electric vehicle adoption. The installation of a charging power station is significantly easier, but it is tough to manage due to a lack of information. Knowledge will undoubtedly help to enhance the current status of infrastructure. With this, we arrive at the following facts: withthe number of vehicles on the road expected to double in thenear future, the necessity for alternating energy is obvious and has promising returns. Producing vehicles that do less, have a longer range, and consume less energy is critical.

Electric vehicles have greatly decreased carbon emissions in the areas where they are deployed. It helps to restore the eco system's balance to some extent.

REFERENCES

[1] Songming Zhu et al, “SCUC – based optimal power tracing approach for scheduling physical bilateral transactions and its verification via an integrated power money flow analysis”, *Wiley Publication, ISSN* 1751 – 8687, April 2016.

[2] Zhile Yang et al, “A comprehensive study of economic unit commitment of power systems integrative varions renewable generations and plug in electric vehicle, *Energy conversion & management* (460 – 481), November 2016

[3] C. Chellaswamy, R. Ramesh, "Future renewable energy option for recharging full electric vehicles," *Renewable and Sustainable Energy.Reviews*, vol. 76, pp. 824–838, 2017.

[4] Niresh J, Dr.Neelakrishanan, Muthu C, Sabareesh G, Saravanan P, Tharan Vikram S, “Mitigating Instability in Electric Drive Vehicles Due to Time Varying Delays with Optimised Controller”, *International Journal of Advanced Engineering Research and Science*, 2017.

[5] Hamidreza Kamankesh et al, “Optimal scheduling of renewable Micro – Grids considering plug – in Hybrid electric vehicle charging demand”, *Energy 100* (285 – 297), January 2017.

[6] Mizumoto, I., Yoshii, Y., Yamamoto, K., & Oguma, H., “Lead-acid storage battery recovery system using on–off constant current charge and short–large discharge pulses”, *Electronics Letters*, 54(12), 777-779, 2018.

[7] Rezel Khorram – Nia et al, “Optimal switching in reconfigurable micro-grids considering electric vehicles and renewable energy sources”, *Journal of Renewable and Sustainable Energy*, 10, July 2018.

[8] Saniya Maghsudlu et al, “Optimal scheduled unit commitment considering suitable power of electric vehicle and photovoltaic uncertainty”, *journal of renewable energy and sustainable energy10*, July 2018

[9] ‘Power Sector at a Glance ALL INDIA | Government of India | Ministry of Power',glance-all-india, accessed May 20, 2018

[10] Yuan Kang wu et al, “Review of security constrained unit commitment in a large power”, *International conference of Applied system innovation* 2018.

[11] Atul Jaysing Patil, Arush Singh and R.K. Jarial, "A Novel Fuzzy Based Technique For Transformer Health Index Computation", *2019 International Conference on Advances in Computing Communication and Control (ICAC3),* pp. 1-6, 20–21 Dec , 2019

[12] Alinson S. Xavier et al, “Transmission constraint filtering in large scale security constrained unit commitment “, *IEEE Transaction on power system*, vol.20, no. 2019.

[13] Atul Jaysing Patil, Arush Singh, “A Literature Review: Traditional and Advanced Protection Schemes of Power Transformer”, *IJISSET Journal*, 2019

[14] Atul Jaysing Patil, Arush Singh, R. K. Jarial , “Some Aspects of Design And Condition Monitoring of Electric Power Transmission Towers”, *IJISSET Journal*, Volume: 5 Issue: 10, 2019

[15] Arush Singh, Atul Jaysing Patil, and R.K. Jarial A Fuzzy Modeling Technique to Assist Submersible Inspection Robot for Internal Inspection of Transformers”, *2020 Fourth International Conference on Inventive Systems and Control (ICISC),* pp. 284-290, (2020)

[16] Atul Jaysing Patil, Arush Singh and R.K. Jarial, "An Integrated Fuzzy based Online Monitoring System for Health Index and Remnant Life Computation of 33 kV Steel Mill Transformer", *IEEE International Conference On Industry 4.0 Technology 2020 (I4Tech2020),* pp. 176-181, 14 Feb, (2020)

[17] Arush Singh, Atul J Patil, Rajiv Kumar Sharma, RK Jarial, "An Innovative Fuzzy Modeling Technique For Transformer's Failure Modes And Effects Analysis", *2020 International Conference on Electrical and Electronics Engineering (ICE3),* pp- 240-245, (2020)

[18] Avinash Vinod Shrivastav, Sajidhussain Sakirhussain Khan, Rahul Krishna Gupta, Prajkta Ramdas Ekshinge, Parmeshwar N suryawanshi, "Electric Vehicle Charging Station (Case study on infrastructure of EV charging station)", *Journal of Emerging Technologies and Innovative Research,* Vol. 7, April-2020,

[19] Bugatha Ram Vara Prasad, C. Prasanthi, G. Jyothika Santhoshini, K. J. S. V. Kranti Kumar, and K. Yernaidu, "Smart Electrical Vehicle," *i-manager's J. Digit. Signal Process.*, vol. 8, no. 1, p. 7, 2020,

[20] Bugatha Ram Vara prasad, "Highway Monitoring System and Power Saving," *IJCRT Journal,* vol. 8, no. 4, pp. 2270–2274, 2020.

[21] H. S. Das, M. M. Rahman, S. Li, and C. W. Tan, "Electric vehicles standards, charging infrastructure, and impact on grid integration: A technological review," *Renew. Sustain. Energy Rev*., vol. 120, no. November, 2020,

[22] Sanja Cvjic et al, "Security constrained unit commitment and economic dispatch through benders decomposition: A comparative study", *2011 IEEE Power and Energy Society General Meeting*, Oct 2011

[23] Chengcheng shao et al, "cooperative dispatch of wind generation and electric vehicles with battery storage capacity constraints in SCUC", *IEEE Transactions on Smart Grid*, Volume: 5, Issue: 5, September 2014

[24] Mohsen Ramezanzadeh et al, "Security constrained unit commitment in the presence of demand response programs and electric vehicle" , *International journal of Indian economics* , vol. 03, (313 – 326), July 2020.

[25] Xin Zhu et al, "Security constrained unit commitment with extreme wind scenarios", *journal of modern power system,* vol. 08, no.03, May 2020.

[26] Arush Singh, A J Patil, Vivek Kumar Tripathi, Rajiv Kumar Sharma, RK Jarial, "Reliability Modelling and Simulation for Assessment of Electric Arc Furnace Transformers", *2020 IEEE International Conference on Computing, Power and Communication Technologies* (GUCON), pp. 239-244, 2020

[27] Saurabh Ranjan Sharma, OP Rahi, Arush Singh, Atul Jaysing Patil "A New Methodology for Risk Analysis for Excitation System of Alternator in SHP using FIS", *2020 4th International Conference on Intelligent Computing and Control Systems (ICICCS),* 2021

[28] Sagar S Patil, A J Patil, Arush Singh, Megharani A. Patil, R. K. Jarial, "Hardware Implementation of a Smart Technique Five Level Inverter Based STATCOM to Mitigate Power Quality Issues" *IEEE Conference SMARTGENCO*, 2021

[29] Atul Jaysing Patil, Arush Singh, Sagar S Patil, Megharani A Patil, R. K. Jarial, "Root Cause Analysis & Predictive Electro-Mechanical Interaction Analysis Algorithm Development for Minimizing Electric Arc Furnace Transformer Degradation", *IEEE Conference SMARTGENCO,* 2021