Smart EV Charging Hub Integrated with Renewable Energy for Highway Utility

M.Abinesan[1], S.Jawahar [2], S.A.Gopi[3], A.Gokulraj [4], S.Saravanan[5]
UG Scholars[1,2,3],Assistant Professor[4], Professor[5], Department of Electrical and Electronics Engineering, Muthayammal Engineering College, Tamil Nadu, India

Abstract–With the rise in the demand for electric vehicles, the need for reliable charging infrastructure to accommodate the rapid public adoption of this type of transportation also increases. The cost reduction of charging systems, development of battery charging stations for electric vehicles based on renewable energy has started. The objective of this project is to design IoT based cost effective E-vehicle charging system using hybrid power (Solar, Wind and Piezoelectric). Human activity is overloading our atmosphere with carbon dioxide and other global warming emissions. These gases act like a blanket, trapping heat, thus resulting in significant harmful impacts like storms, droughts, sea level rise, and extinction. The development of automotive technology is increasing day by day. The Future automotive technology, the electric vehicle plays an important role, as the operating cost of electric vehicle is low compared to present vehicles. This project is buck and boost converter-based system to get higher efficiency of the battery and for charging application. Arduino microcontroller-based charging system is designed to charge battery through hybrid power. The IOT system is used to find out the charging condition of battery and monitor the power production. The LCD display is provided to display the converter output voltage and battery voltage.

Keywords - Solar panel, vertical axis windmill, and piezo electrical crystal, (PWM) buck-boost converter, battery, Arduino UNO board,smoke sensor, display, buzzer, IoT.

I.INTRODUCTION

We have constructed the combination of solar energy, wind energy and piezoelectric energy based renewable energy system for electric vehicle charging station. The solar panels will be placed at both sides of the highway, vertical axis wind energy will be place at the centre of the highway and piezo electrical crystal will be placed on the road. Based on the power production the renewable energy charging source will be selected. We used three types of renewable energy to produce the electrical energy in all-weather condition. We need to place this type of EV charging station at every 50km range on the highways, to achieve reliable charging infrastructure. When the sun rays strike the solar panels electric charges are produced. These electrical charges move in response to an internal electrical field in the cell, causing electricity to flow. The vertical axis wind turbine working principle is that, the rotors in the turbine revolve around a vertical shaft by using vertically oriented blades and they generate electricity by using wind power. The wind operatesthe rotor which is connected to the generator, so the generator converts the energy from mechanical to electrical. Vertical axis wind turbine components are blade, shaft, bearing, frame & blade support. The working principle of a Piezoelectric is based on the fact that when a mechanical force is applied on a piezoelectric crystal, a voltage is produced across its faces. Thus, mechanical phenomena are converted into electrical signal. After collecting the energy is stored in charging hub battery and to prevent battery fire, we provide the fire alert signal to fire station or corresponding technical persons. The IOT system is used to find out the charging condition of battery so that the distance coverage of the vehicle can be determined. The LCD display is provided to display the converter output voltage and battery voltage.

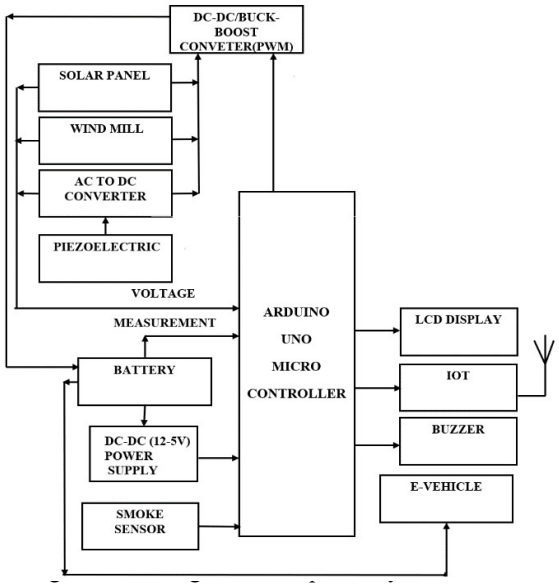
II.EXISTING SYSTEM

EV charging using solar energy charging station will play an important role in increasing demand of EV in market, lesser number of charging infrastructure is the main disadvantage of Electric Vehicle. The optimal charging hybrid strategy can help in reducing the dependency of charging station on grid, like we can deploy charging infrastructure in home, offices, hospitals and parking using solar energy. The instalment of charging infrastructure should not fully depend on government body, some private organization should be tendered for maintenance also. In this paper, a 10 KW EV-PV charger is going to be considering that gives charging of EV. Solar based EV charging station Power developed from solar is variable in nature as the intensity of solar radiation is not constant. So, we are going to use a battery, which will act as a storage tank for solar produced energy. The battery will charge itself and deliver power to recharge EV's battery; the charging condition will work till it is 90 percent charge then after it will stop charging and only discharge. There is also a condition for

EV that when it will be 80 percent charge then the rate of charging will be slow and the other EV in queue will start charging at its maximum rate. the azimuth angle and orientation angle calculation are done.

III.PROPOSED SYSTEM

This project is about charging E-vehicle module using the Solar panel, wind power, piezoelectric availability of maximum power is viewed by IOT device and the maximum power generated by the solar is being tracked using the Arduino controller. The whole setup is connected to the PIC microcontroller, Buck boost Converter, the battery level, battery level is viewed using an LCD. IOT module is used to get an alert message for any reduction of power occurred in the system. IOT server is used to check the availability status of charge, the amount of power transferred to the charging module and the available location for the charging station can be displayedshown in the fig 1. The main idea of this project is to reduce greenhouse gas emission by reducing fossil fuel usage.The new method for improving EV charging station performance and reduce global warming by fully renewable energy powered.



IV.SIMULATION

We use Proteus simulation tool for design and analysis of the proposed system. The simulation circuit has been designed in Proteus software using the respective components present in the tool, to get the desired output. This simulation circuit will be described in detail below. This chapter describes the design and current implementation of the Proteus dependability manager and object factory. The application requirements and the type ofapplication that Proteus currently supports are also described. Proteus PIC Bundle is the complete solution for developing, testing andvirtually prototyping the embedded system designs based on MicrochipTechnologies series of microcontrollers. This softwareallows to perform schematiccapture and simulate the circuits designed.The renewable e-vehicle charging station is designed with solar PV module, piezoelectric module, and a vertical axis wind turbine. Smoke sensor is used to detect fire shown in the fig2. The total power generation of the designed charging station is monitored and controlled by IoT and parameters are viewed using the display. The average power of EV charging station isdetermined by statistical analysis.

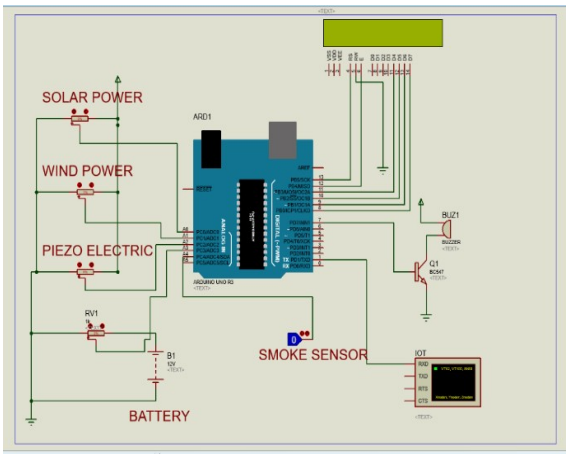


Fig 2: Simulation circuit

In this simulation various parameters of the solar module, wind energy and piezoelectric energy have been measured. The voltage generated in renewable energy has been varied by using variable resistor. From theoutput generated by the hybrid system, enough power forrecharging the electric vehicle charging station maintain the rated voltage is achieved by the PWM control signal is monitored using IoT. If any fire will be detected by the smoke sensor in the battery compartment, then the buzzer will get activated and will alert using IoT as shown in the fig. Arduino Software (Ide):The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino and Genuino hardware to upload programs and communicate with them to program as per the requirements.

V.HARDWARE IMPLEMENTATION

To power Arduino UNO board the power supply is taken from the battery through the DC-DC converter(12-5V). The renewable electric energy generated from the solar panel, vertical axis windmill and piezoelectric plate is given to battery through PWM converter. The voltage measuring unit measured the voltage from the solar panel, vertical axis windmill, piezoelectric plate and battery terminal respectively given to input block of Arduino. The smoke sensor is connected to the input block of Arduino. The control signal of PWM converter, display, buzzer and IoT are connected to output block. The DC motor (EV) is connected to battery. The hardware prototype is shown in fig

Fig 3: Hardware implementation

The Arduino compare the voltage generation of each renewable electric energy generated and pre-set rated voltage output to battery. Then the PWM control signal is given by the Arduino to the PWM(Buck-Boost) DC-DC converter to set the rated voltage output to the battery. From the output generated by the hybrid system, enough power for recharging the electric vehicle charging station battery is monitored using display and IoT (android studio).If any fire and smoke will be detected by the smoke sensor in the battery compartment, the buzzer will get activated by smoke sensor and alert using IoT (android studio) as shown in the fig 5 and fig 6.

VI.CONCLUSION

We have designed a renewable energy-based hybrid electric vehicle charging to improve battery life and efficiency. Project main objective is to charge the battery by using renewable energy method, and deep cycle batteries. The electric vehicle will play an important role in future. We are implementing a new method for improving EV charging station performance and reduce global warming. The main reason for using electric vehicle is that the fuel price is expensive and increasing. Due to this scenario, many vehicle manufacturers are looking for alternative energy sources other than gas. The use of electrical energy sources may improve the environment since there is less pollution. To improve the electric vehicle charging features, we create an optimized IOT based system to sense the condition of the batteries and monitor the power production. The IOT continuously tracks the renewable energy sources condition and based on the energy availability the renewable energy source will charge the battery.

REFERENCES

[1] MounaLamnadi, Mourad Trichi, Abdelkader Boulezhar, Study of a hybrid renewable energy system for a rural school in Tagzirt, Morocco, Published 1 November 2016, International Renewable and Sustainable Energy Conference, (IRSEC).DOI:10.1109/IRSEC.2016.7984079.

[2] Mr.R. Nagaraj Renewable Energy Based Small Hybrid Power System Project, Bhabha Atomic Research Center, Kalapakkam, India, 2012 IEEE 5th India International Conference on Power Electronics (IICPE),DOI:10.1109/IICPE.2012.6450437,Corpus ID: 31443389.

[3] Harshal Dattatray Vaidya "DC-DC Switched Inductor Boost Converter for DC Drives Applications", International Journal of Engineering Trends and Technology (IJETT), V53(2),90-94 November 2017. ISSN:2231-5381.

[4] Zhou, H.; Liu, Q.; Yan, K.; Du, Y. Deep Learning Enhanced Solar Energy Forecasting with AI-Driven IoT. Wirel. Commun. Mob. Comput. 2021, 2021, 9249387.

[5] Lamnadi, M., Trihi, M., Boulezhar, A. and Bossoufi, B. (2019) 'Optimal design of stand-alone hybrid power system using wind solar energy source', Int. J. Energy Technology and Policy, Vol. 15, Nos. 2/3, pp.280-300.

[6] Abbas U, D.; Alkahtani, A.A.; Tiong,S.K. Review of Renewable Energy-Based Charging Infrastructure for Electric Vehicles. Appl. Sci. 2021, 11, 3847.https://www.researchgate.net/deref/https%3A%2F%2Fdoi.org%2F10.3390%2Fapp11093847.

[7] Alsema, E.A. and Nieuwlaar, E. (2000) 'Energy viability of photovoltaic systems', Energy Policy, Vol. 28, No. 14, pp.999–1010.

[8] IEEE Std 178-1958 (R1972), Standards on Piezoelectric Crystals: Determination of the Elastic, Piezoelectric, and Dielectric Constants of Piezoelectric Crystals Ñ The Electromechanical Coupling Factor.

[9] Jon Decoste, Denise Mckay, Brian Robinson, Shaun Whitehead, Stephen Wright. Supervisors: Dr. Murat Koksal, Dr. Larry Hughes, Mech 4010 Design Project Vertical Axis Wind Turbine. Department Of Mechanical Engineering, Dalhousie University, December 5, 2005.

[10] S. A. Sulaiman, M. N. H. Mat, F. M. Guangul, and M. A. BouRabee, "Real-time study on the effect of dust accumulation on performance of solar PV panels in Malaysia," in Electrical and Information Technologies (ICEIT), 2015 International Conference on, 2015, pp. 269-274.