# Electric Vehicle Charging System Powered by Solar PV with Backup Power

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*Abstract* — The SPV-based charging system is described in this paper. It can operate as a source of power for the infrastructure where it is situated by drawing electricity from the batteries of electric vehicles in emergency situations, or when the grid is down. On Matlab, the simulation is carried out with a single-phase system. The system consists of two sources, solar and grid, respectively, and in times of emergency, the EV's batteries serve as a source.

***Keywords:*** Power Back-Up, Solar PV Array, EV's

## I. Introduction

An enhanced charging infrastructure is required for the successful propulsion of EVs because to the rapid advancement in technology and their rising popularity. [1] In essence, electricity produced from traditional or unconventional energy sources could be used to power the charging. Yet, a charging station supplied by a renewable energy source is thought to be the best for making the idea of EVs completely environmentally benign. [2]

Tidal, geothermal, solar, wind, and other renewable energy sources are just a few of the many forms that exist on Earth. Due to its widespread availability, the usage of solar PV array for EV charging stations is preferred the most. Because there are no moving parts, installation is simple and maintenance is minimal.[3]-[4]

After a single investment, the solar-powered charging system with power backup offers several benefits to the infrastructure where it is installed. It gives EVs free fuel for the duration of their lifespans (20 to 25 years), and it also eliminates the need for power backup sources like diesel generators, inverters, etc. by being able to supply the load from the EV batteries in an emergency. [5]-[6]

## II. System Description

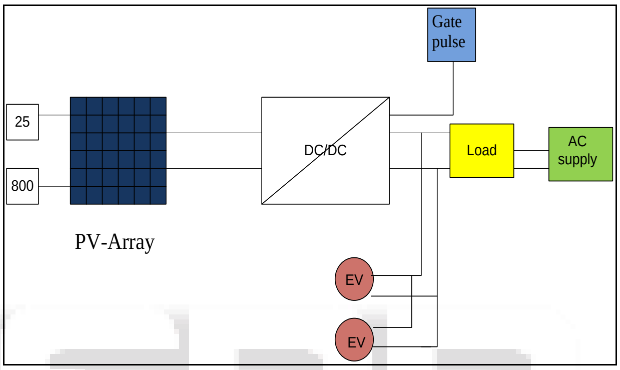


Fig. 1: Block diagram of the system

### A. PV Array

One Soltech 1STH-215-P solar PV array is employed, comprising 40 parallel strings and 10 series modules. The PV array's PV and IV parameters are as follows.

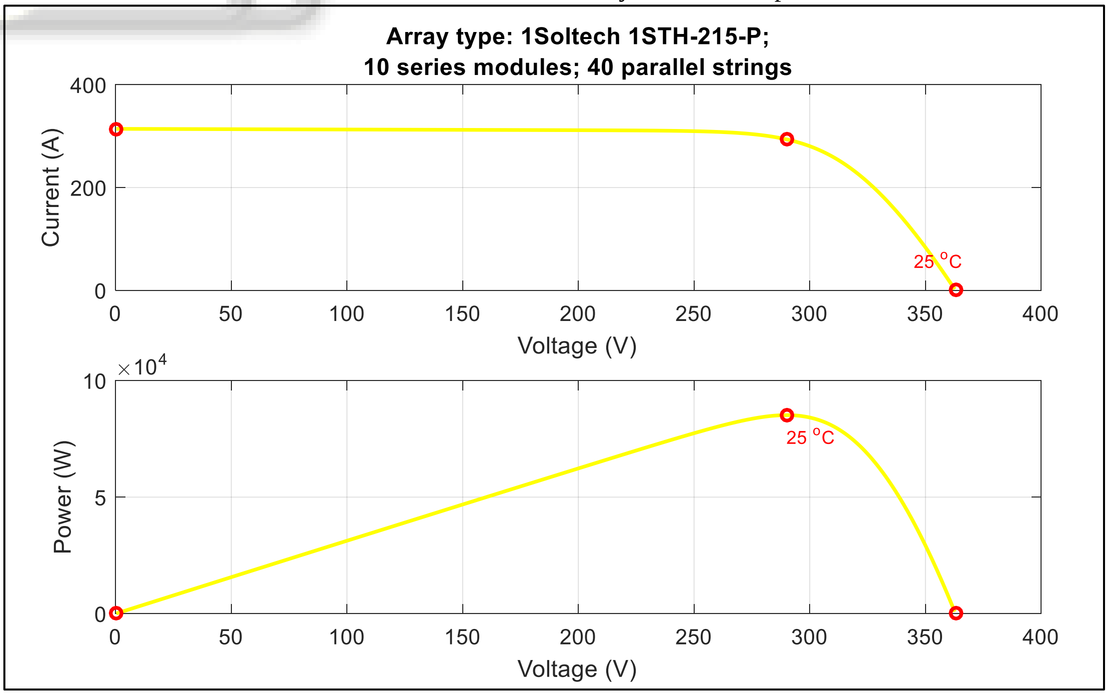


Fig. 2: The PV array's PV and IV properties are as follows.

*1) Characteristics of a PV array*

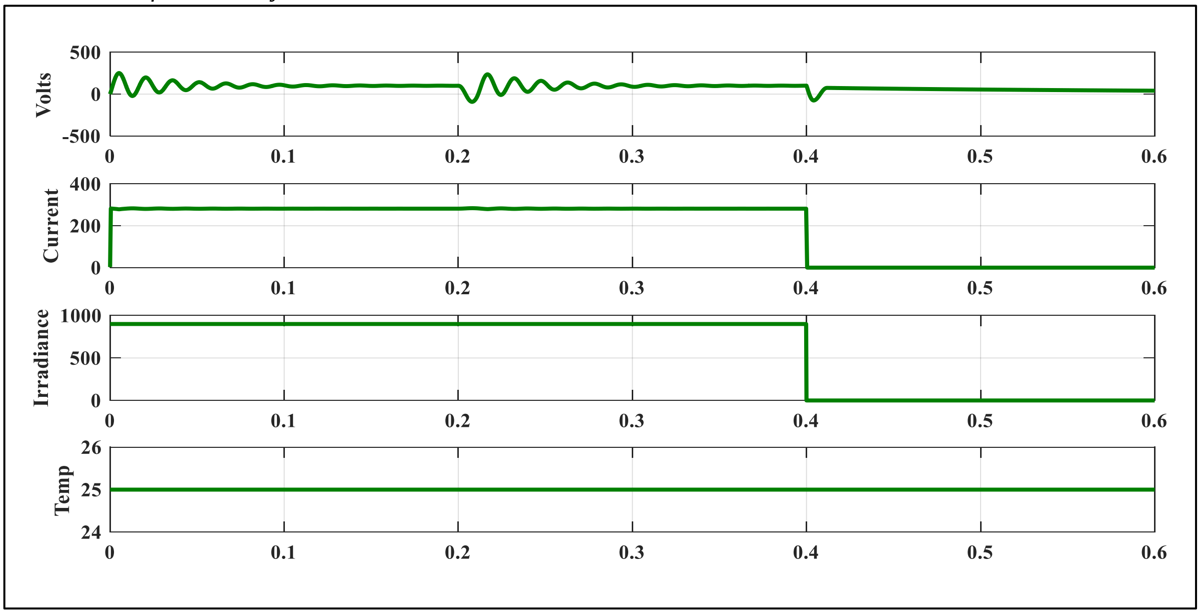


Fig. 3: The output waveform of the PV array used in this system

### *B. Boost Converter*

A boost converter is a DC-DC converter that increases voltage from its input to output (while decreasing current). It falls within the category of switch mode power supplies (SMPS) that includes at least two semiconductors (a diode and a transistor) and at least one energy storage component (a capacitor, an inductor, or both separately or together).[7]-[8]

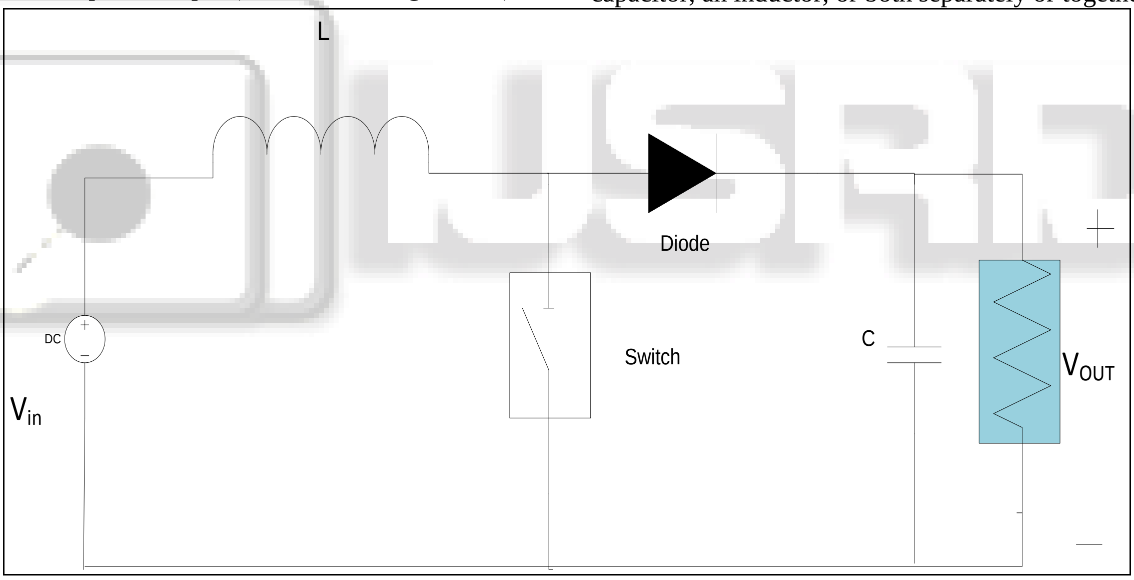


Fig. 4: Basic diagram of a boost converter

### *C. R-L Load Inverter for Single Phase Full Bridge Inverter*

For a single-phase load, a single-phase square wave type voltage source inverter generates square shaped output voltage. When compared to switches in some other types of inverters, the power switches in such inverters require substantially lower operating frequencies.[9]-[10]. A type of Single phase full-bridge inverter used to convert DC power into AC power is called a full bridge inverter. In comparison to single phase Half bridge inverters, conversion requires two twice as many components. When compared to all other loads, the full bridge's functioning for a pure resistive inductive load is the simplest. Just control switches are active in the load since there is no storage component there; feedback diodes are not active due to the inverter's functioning. To comprehend how a complete bridge inverter for RL load operates, just two modes are required.

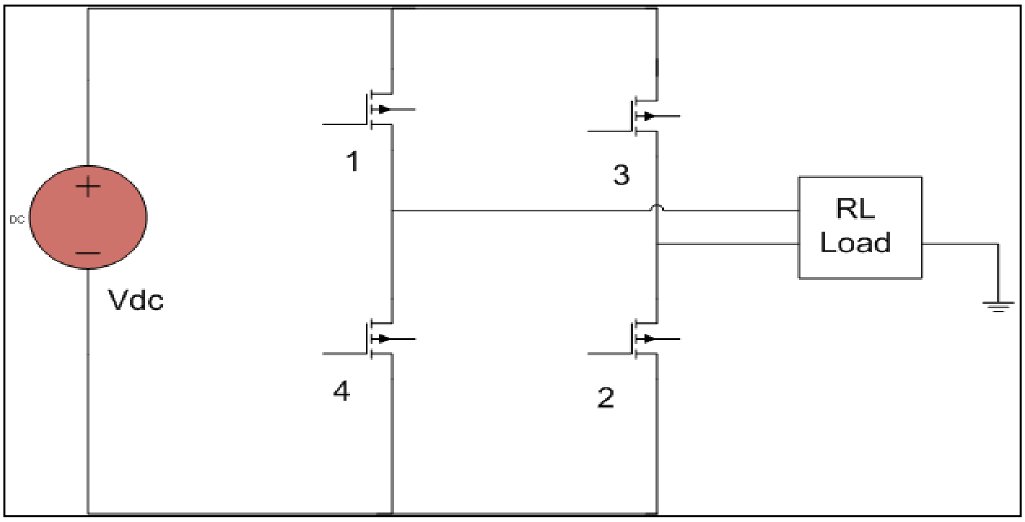


Fig. 5: Basic diagram of a single phase inverter

Supply of single-phase AC Under typical circumstances, a supply with a peak voltage of 180 volts and a frequency of 50 Hz is used to serve the load.

*D. Load*

In this setup, a 5000-ohm resistive load is applied.

*1) Working of the System*

This system's operation is essentially explained in three ways.

– MODE-I Both the grid and the SPV are operational in this mode, with the grid supplying the load and the solar panels charging the batteries of electric vehicles.
– MODE-II In this mode, the grid is not present, and the solar power both charges the EVs' batteries and maintains the supply throughout the load via a single-phase inverter.
– MODE-III The batteries of the EVs supply the load in this mode, which also results in their batteries discharging.

*E. Simulation model and results*

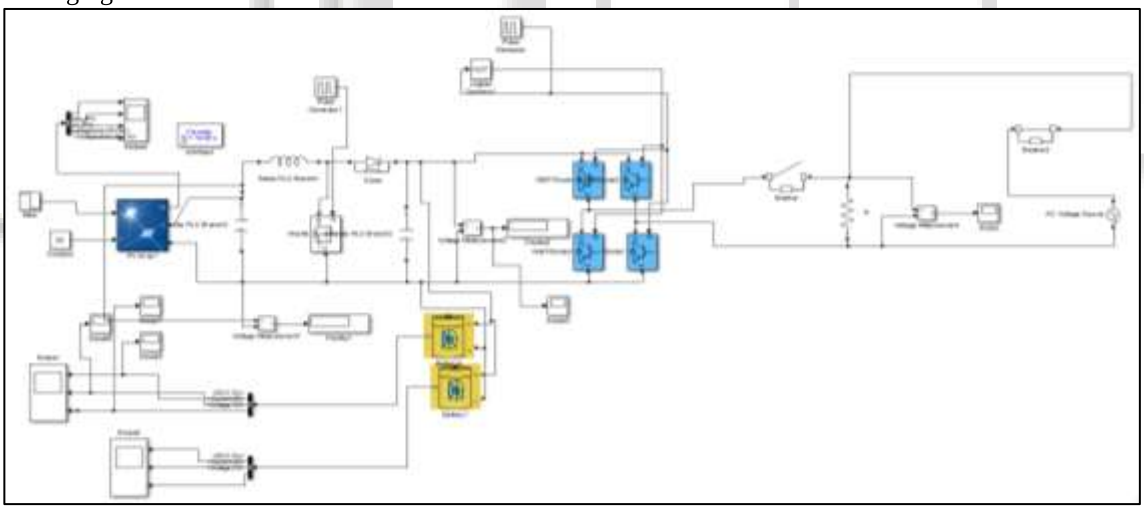

Fig.6. Simulation model of the system in Matlab

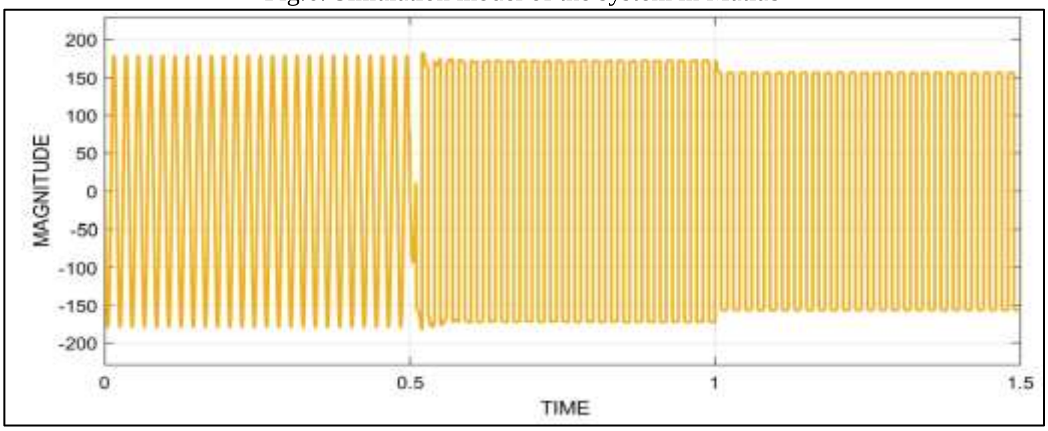


Fig. 7: Output waveforms across the load

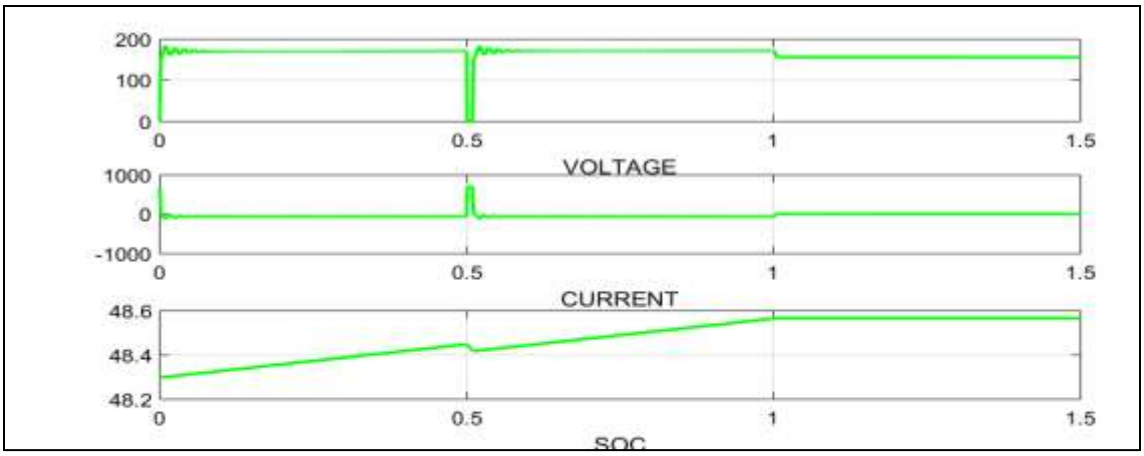


Fig. 8: Output waveforms across the Batter

In Mode 1, that is, between 0 and 0.5, The output waveforms across the load exhibit sinusoidal waveforms because the load is currently being supplied by the grid, and the output waveforms across the battery exhibit rising SOC values because the battery is currently being charged by the solar PV array. From time period 0.5 to 1

In Mode 2 In the absence of a grid, the output waveforms across the load and the battery both exhibit a growing SOC as the solar PV array charges them, respectively. The output waveforms across the load can be viewed as a square wave.

In Mode 3, which is between 1 and 1.5 seconds, Due to the lack of both the sources (solar and grid), as well as the discharging of the batteries, the output waveforms across the battery indicate a square wave of around 144 volts that is delivered by the battery via a single phase inverter.

## III. CONCLUSION

The charging station designed for this system proved to be a very cost-effective method by doing away with the need for pricey power backup sources. Additionally, it offers the EVs free fuel for the duration of their lives. By using specific control approaches, the system could be further improved and made more helpful.

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