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Solar Charger Design for Electric Vehicles

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ABSTRACT- As countries and car makers focus on goals like "going green," combating climate change, and so on, the present worldwide trend toward electric vehicles is expanding. The design of electric vehicles is an important aspect of this. Electric cars are powered by electricity generated by a power source, most often batteries. These batteries require charging. A charging station must be supplied for this reason. The charging stations or points transform the energy they have access to from a variety of sources into DC electrical energy for the automobile. These devices had to be willing to handle human input, namely the amount of power to be used, in order for the user to pay for what they need. In this paper, an electric car is charged using a local bank capacity, a PV Powerwall is available. This simulation sets the foundation for solar-powered electric vehicle (EV) charger designs.

KEYWORDS- Electric Vehicles, Charging Station, DC, Batteries

I. INTRODUCTION

Electric cars first appeared in the late 1800s but were quickly surpassed by electrically powered engine-powered vehicles launched in the early 1900s. Because of inefficiencies and inadequate battery technology, this happened.

To begin with, the utilization of renewable technologies such as solar energy has been more available to a large readership as the cost of the solar panels has decreased [1]. With their large interfacial area on flat roofs, construction plants and office buildings in the UK have a lot of potential for renewable (PV) panels. Shipping containers, commercial sites, institutions, refineries, and other structures are representations. This value is now mostly untapped. Moreover, relative to fuel cars, EVs, therefore, provide a green, resource, and buzzing sound mode of transportation. In 2020, the Kingdom is expected to have 200,000 electric vehicles [2]. As described in Fig. 1, this article investigates the possibilities of constructing a diesel motor battery technology utilizing Photovoltaic cells The technology is intended for use in offices to charge personnel's electric cars while they are placed across the day. The goal is to optimize the usage of Photovoltaic for Charging electric vehicles while minimizing grid transmission of power.

EVs became a realistic alternative again. when more advanced lithium-based higher density devices become available by the end of the century, electric vehicles are expected to totally replace existing internal combustion engine (ICE) technology. However, because the energy demand on the grid is quite high, the rising use of these automobiles would put a strain on the current infrastructure and production facilities. As grid operators migrate to smart reserves in order to better maximize power production of producing facilities, these challenges will further diminish the spinning reserves of generators, which are currently quite low.

Because electric cars will eventually replace ICE-powered vehicles, Hundreds of electric vehicles will need to be refreshed. The heat necessary to energize capacitors can also be gained only through storage rating.

There are numerous options for addressing this, including microgrid-based designs, distributed generation, and the usage of renewables.

Renewable energy is especially crucial since it is the next major generating source that has yet to be fully used. The utilization of solar photovoltaics will be investigated in this paper MATLAB software, a brick scripting component of MathWorks' MATLAB environment, was used to run the test.

A charger, a solar array, a storage battery for the charger, and a battery to simulate an EV battery will be included in the simulation

II. OBJECTIVES

The simulation's goal is to create a workable model for charging an electric vehicle tank utilizing a mix of photovoltaic systems and battery storage, as well as a system for directing and maintaining energy flow

III. LITERATURE REVIEW

The idea of charging cars using alternative sources is not new. The charges' appearance, on the other hand, has not yet been investigated properly. They looked at the Destinations, timeframes, and the effect of the weather on the use of solar and wind power for recharge [4-10]

Previously, research has the concentration was always on optimizing the use of formerly accessible power sources for chargers, such as power generation, freshwater, and so on. [8] [11]

Since the sun is just the earth's natural major source of fuel, we're researching solar photovoltaic (SPV)-based charges, comprising over 100 TWh (Terawatt Hour) of energy received. This can significantly minimize grid stress caused by the rising number of electric vehicles on the road. [12-13].

India's efforts to minimize its carbon output and emissions have been thoroughly examined, with findings of India's decision to join its global counterparts in adopting electric vehicles [6]. Furthermore, novel supercapacitors and transmission systems that may be utilized to build the required stations have been investigated in accordance with the required specifications [7–9]. It is essential to differentiate between what 'looks sustainable' and what 'is sustainable' to implement sustainability

IV. METHODOLOGY

A. Brief Introduction

Sunlight PV or SPV programs depend on the star's light source to generate electricity. convert the energy into electricity on specifically constructed panels composed of engineered silicon. This technique absorbs the amount of energy to form electron pairs, which are then filled with fluid via an external device channel to acquire an electric current. PEE (The photoelectric effect,) is a charge-generating effect.

As a consequence of improved production processes and economies of scale, the usage of these panels has increased, and they have become more affordable. However, its application in the feature of blockchain generating is still in its early stages.

As you can see in the image below, a typical panel looks like this. Arrays with substantially larger power capabilities are often formed by connecting them in strings of series and parallel combinations.

Figure 1: Solar Panels

Many panels are installed on steel columns to face the sun for optimal performance, as seen in the previous photograph. Several of these structures are linked together using cables to make enormous arrays. The image presented is a solar tracking array, which follows the sun across the sky.

The image below depicts a solar array erected on a parking lot that might be used for distributed generating. This architecture serves as the foundation for our simulation, with EV chargers drawing power from this array.

Figure 2: Solar Panel Array

The average of the voltages (gained by connecting a line of displays) and indeed the current may be used to calculate the power from an array.

$$P\_Array = (n*V) * (p*I)$$

Wherein.

The number of panels linked in series is denoted by the letter n.

The volume of frames linked in parallel is denoted by the letter p.

The wattage of a single frame is V

I – is a lone court's current

The solar array is designed at 63kW for the sake of this simulation; however, the battery is significantly higher in size for buffering purposes.

B. Battery

Starting with lead-acid batteries in the 1800s and progressing to lithium-based systems today, many types of batteries have been utilized in electric cars.

The lithium-based batteries are made up of many lithium-based cells with a typical output voltage of 3V. These batteries, on the other hand, must not be depleted below a particular voltage to avoid harm. To construct a high-power battery pack for an electric car, multiple of these batteries are linked in series and parallel. A charge controller or BMS (Battery Management System) monitors the temperatures across the pack and opens and closes various valves to maintain the temperature of the overall battery within a narrow temperature range to ensure optimal battery performance. The photos underneath depict a regular EV power pack and BMS.

Figure 3: EV Battery Pack

The Devices are cell sections that involve multiple columns, and so these forms are called branches. joined to form the power line battery pack via the purple wires.

Figure 2: Block BMS Board

This board is a single cell block BMS board. Individual cells are controlled and monitored by it. Each block has its own building management system (BMS). Individual black squares in a line are power MOSFETS that serve as cell control switches.

C. Chargers

For this design, electric car chargers are a form of the Boost conversion, buck rectifiers, and many other DC-DC layouts are examples of Rectifiers. Because different electric cars employ battery packs with varied voltages and capacity, this is the case. A typical EV charger is depicted in the diagram below.

Figure 3: Electric charger

Industry point charger cables are thick due to the fact that they frequently handle trying to charge, which would use kiloamperes of electricity, either steady or pulsed. The concept discussed in this paper employs pulsed charging to stay ahead of a DC-to-DC converter's conduction mode.

V. SYSTEM ARCHITECTURE

The outcome of a test created in Simulink is now described. The whole simulation design may be seen in the image below.

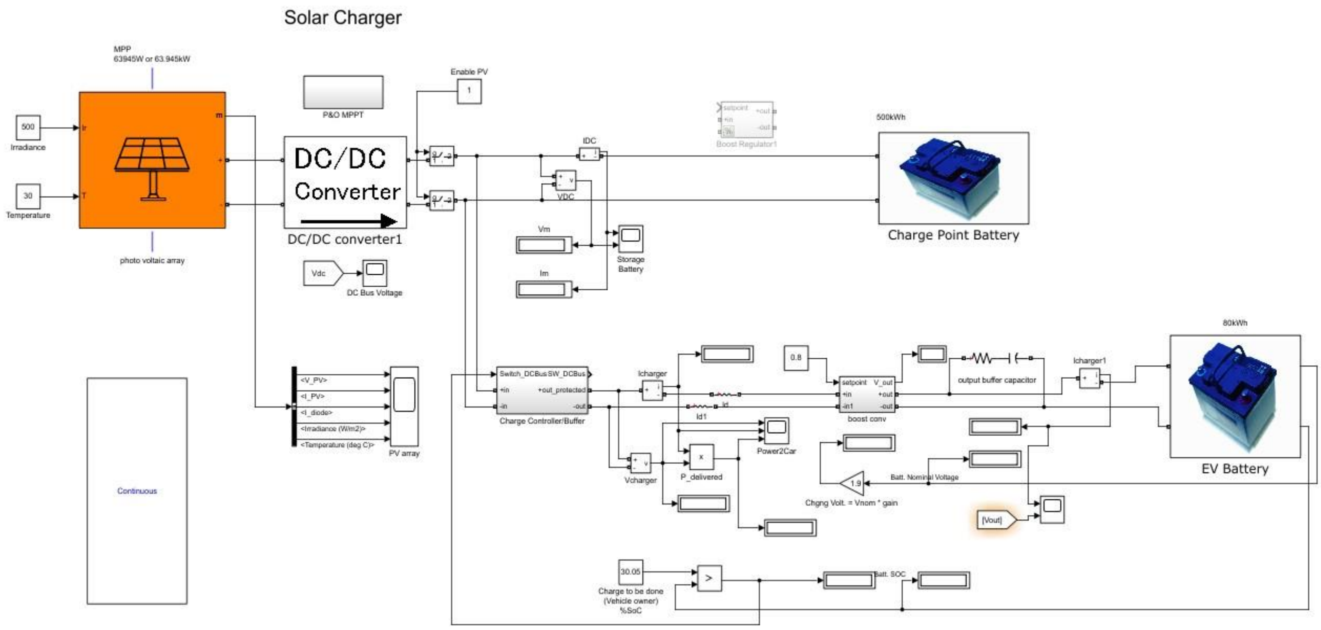

Figure 6: Simulation Design

The solar array block is located in the upper left corner. The charger is in the middle, while the electric vehicle battery is on the right. The charge channel's buffered cell is in the middle block. On the following page, you can see a more detailed image.

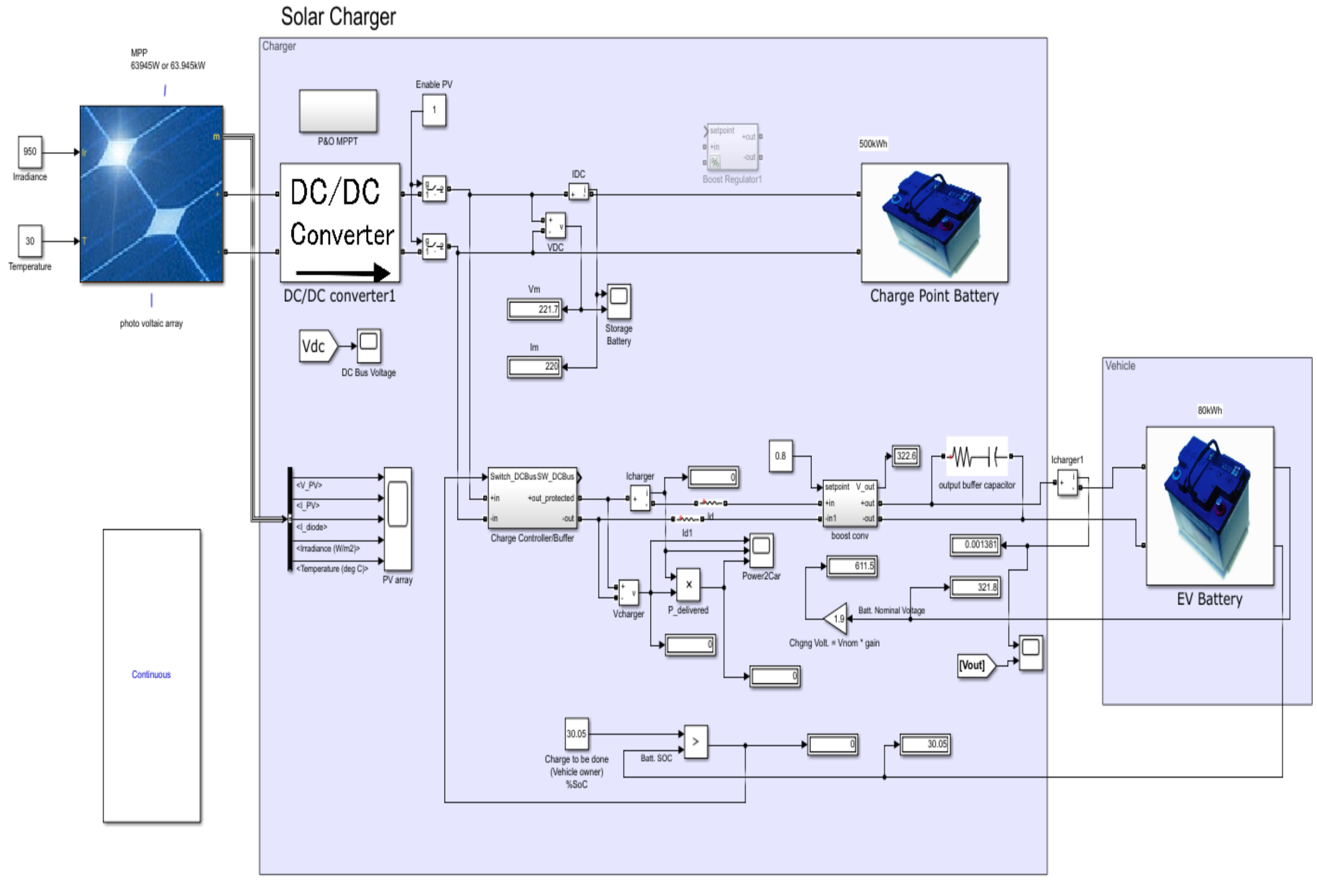

Figure 7: Simulation Circuit

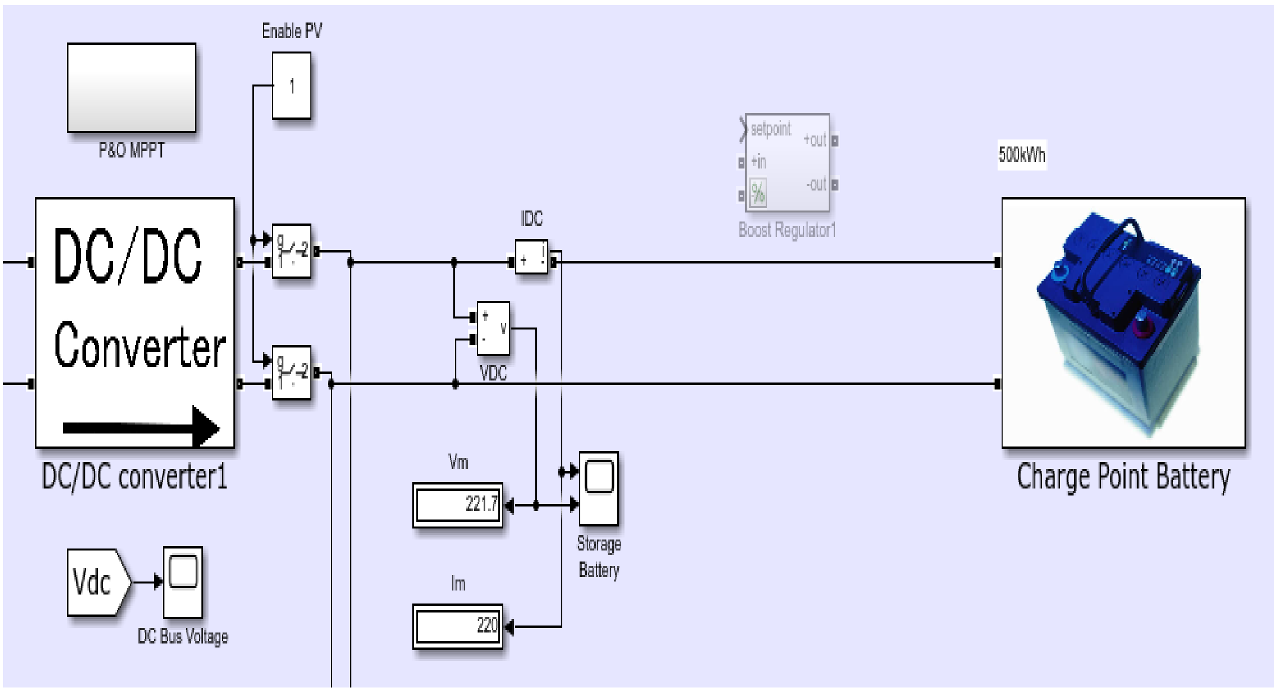

Figure 8: Solar Part of the Simulation

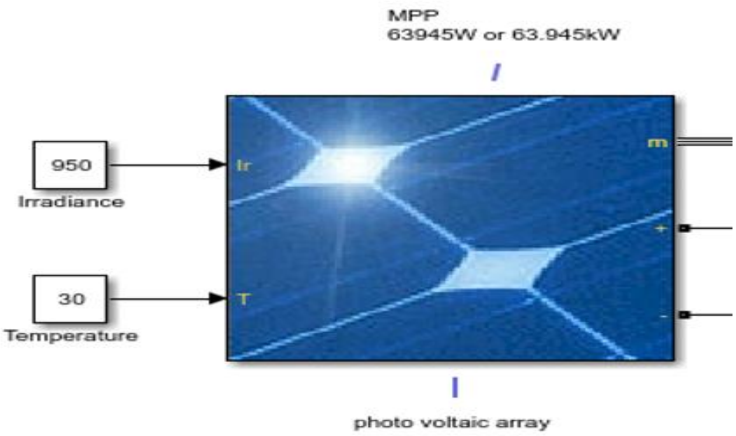

Figure 9: PV Array

This is a MATLAB solar array bloc that is set up to create 63.94 kW of maximum electricity. The warmth and irradiance are set at 950W/m2 and 30 degrees Celsius, respectively.

The panels are linked in series and parallel as shown below to get the necessary power rating.

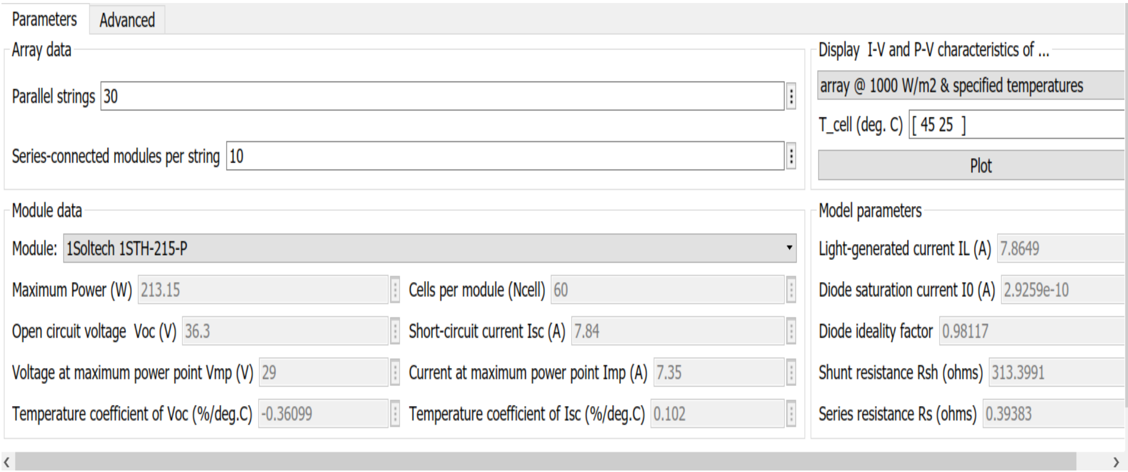

Figure 10: Parallel strings 30 and 10 series strings.

In the preceding image, On the correct hand of the arrangement, the different panel evaluations as given. Maximum power tracking, often known as "P&O" or perturb and observe, is used to collect maximum power from the panel.

A specific amplifier is a DC-DC translator. for this purpose, as seen below.

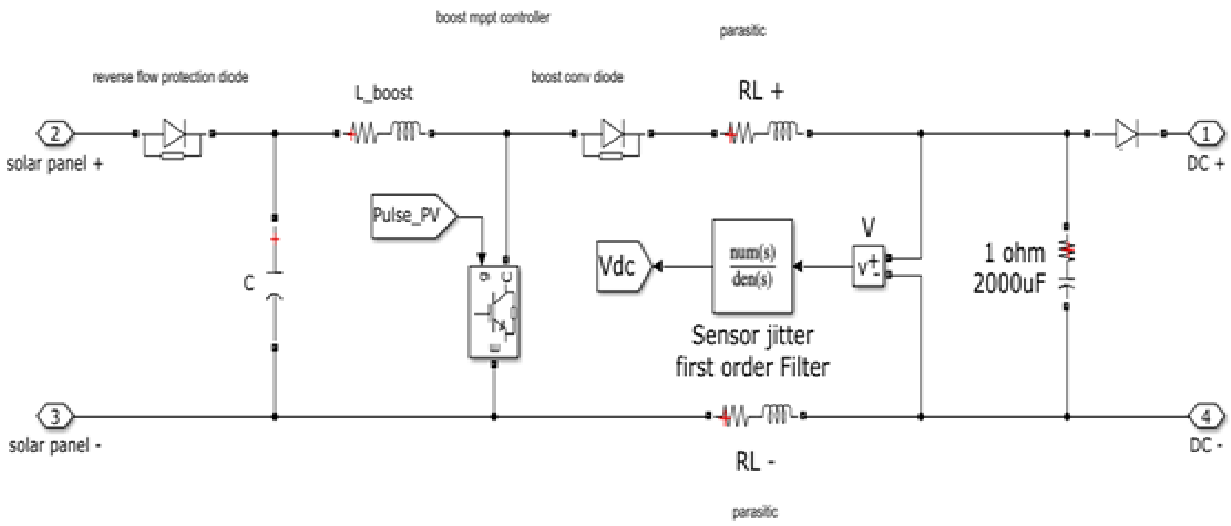

Figure 11: DC-DC Boost Converter Usage

The diodes ensure, no reverse flow of current.

As indicated, state flow block modeling is used to build the MPP approach.

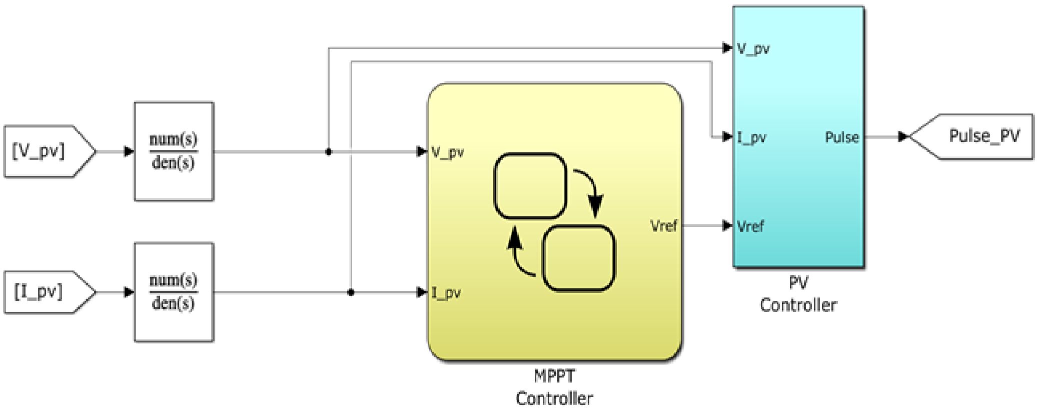

Figure 12: Logic Circuit

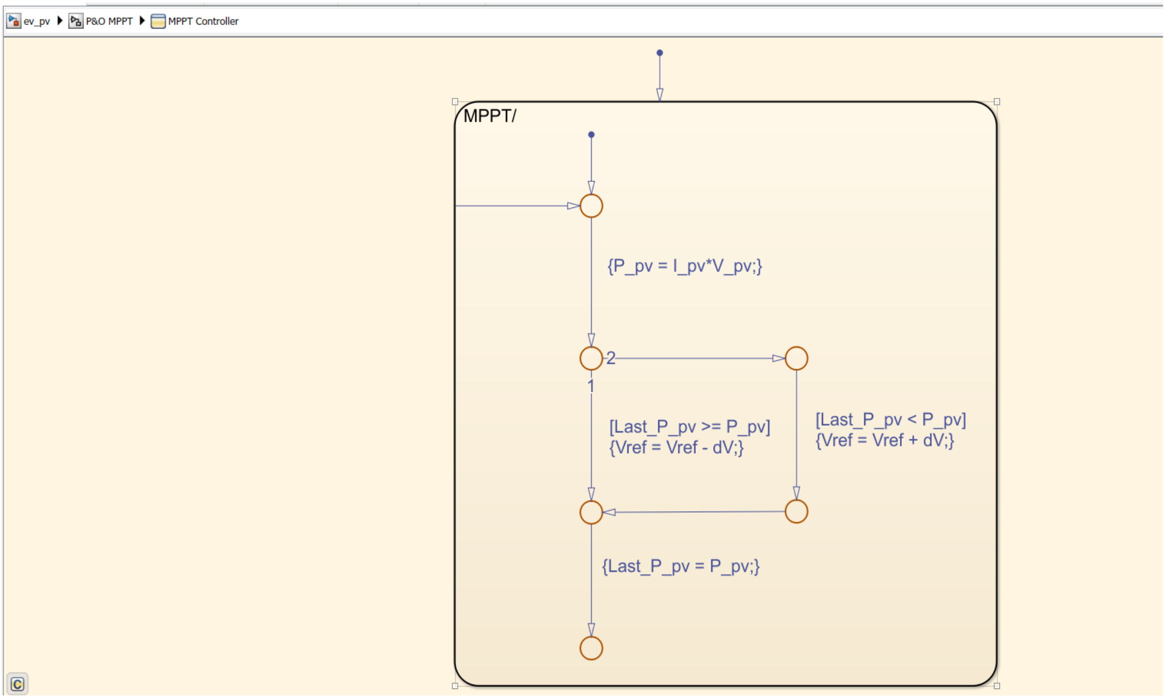

Figure 13: MPPT

The controller constantly chases the higher of the two powers to produce a peak or maximum power from the successive voltage steps.

The regulated pulses, or PWM, are created as follows:

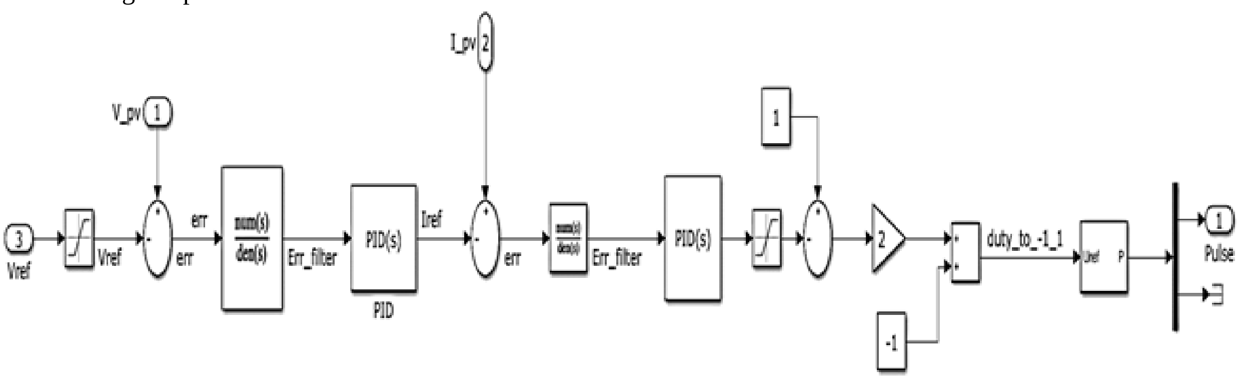

Figure 14: Power Panel Circuit

The power from the panel is controlled using two common control switches;

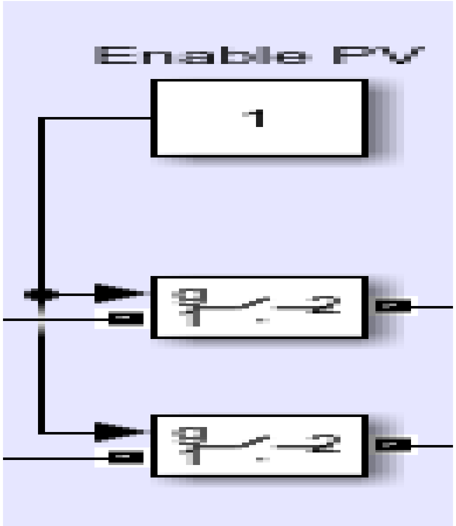

Figure 15: Control Switches

This can be used in cases of maintenance/protection purposes. The arrangement of the buffer battery storage is also given below. It has a larger capacity to accommodate repeated charges for the same or different vehicles, as well as to compensate for line losses. A specialized voltage and current sensor are used to measure the power.

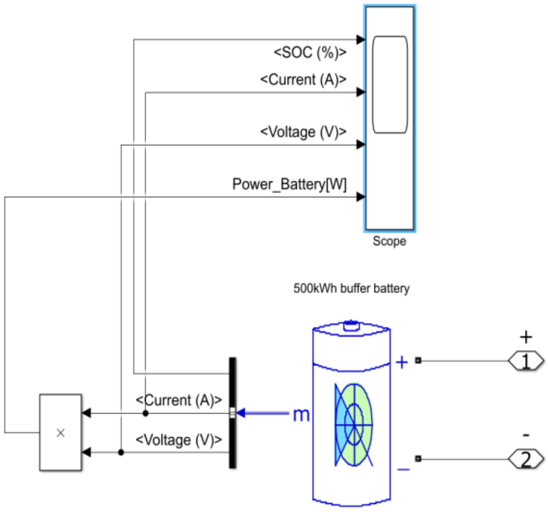

Figure 16: Buffer Battery

The battery has a capacity of 500 kWh. The setup is represented in the diagram following.

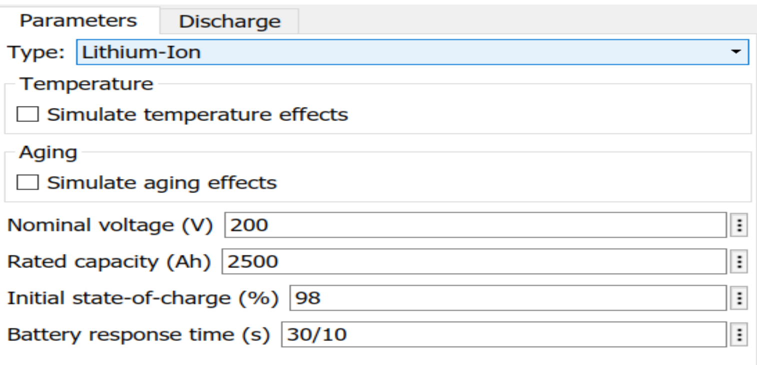

Figure 17: Battery Configuration

Another switch selection provides a control flow to the boost converter for the charger, which also features a dissipating capacitor on the output side.

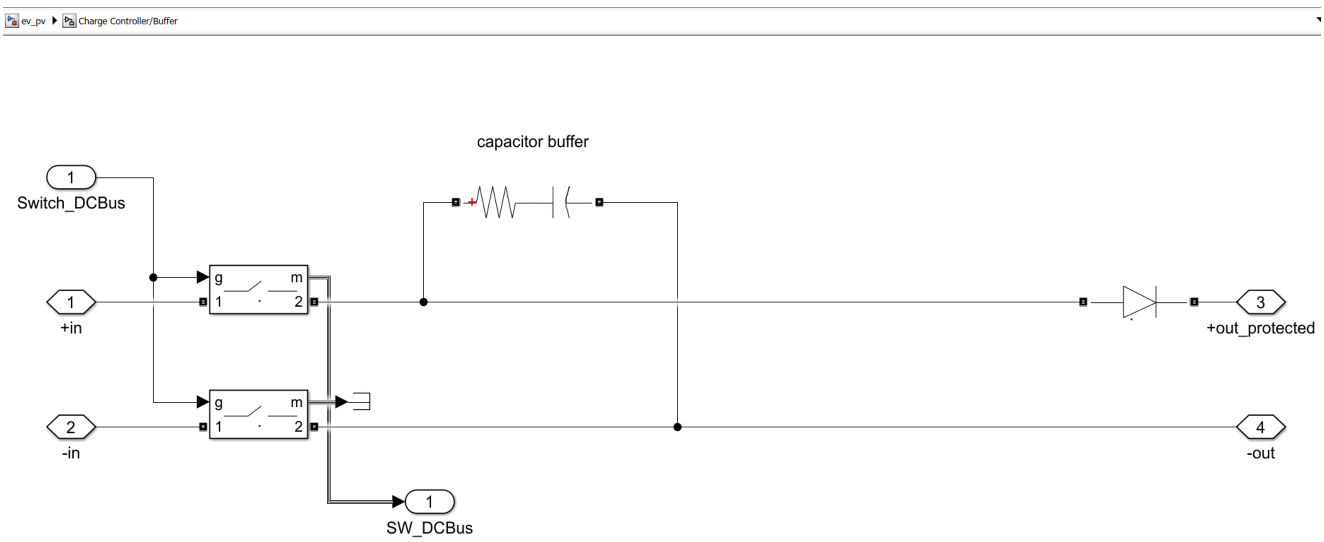

Figure 18: Control Flow Switch

The charger design is shown below.

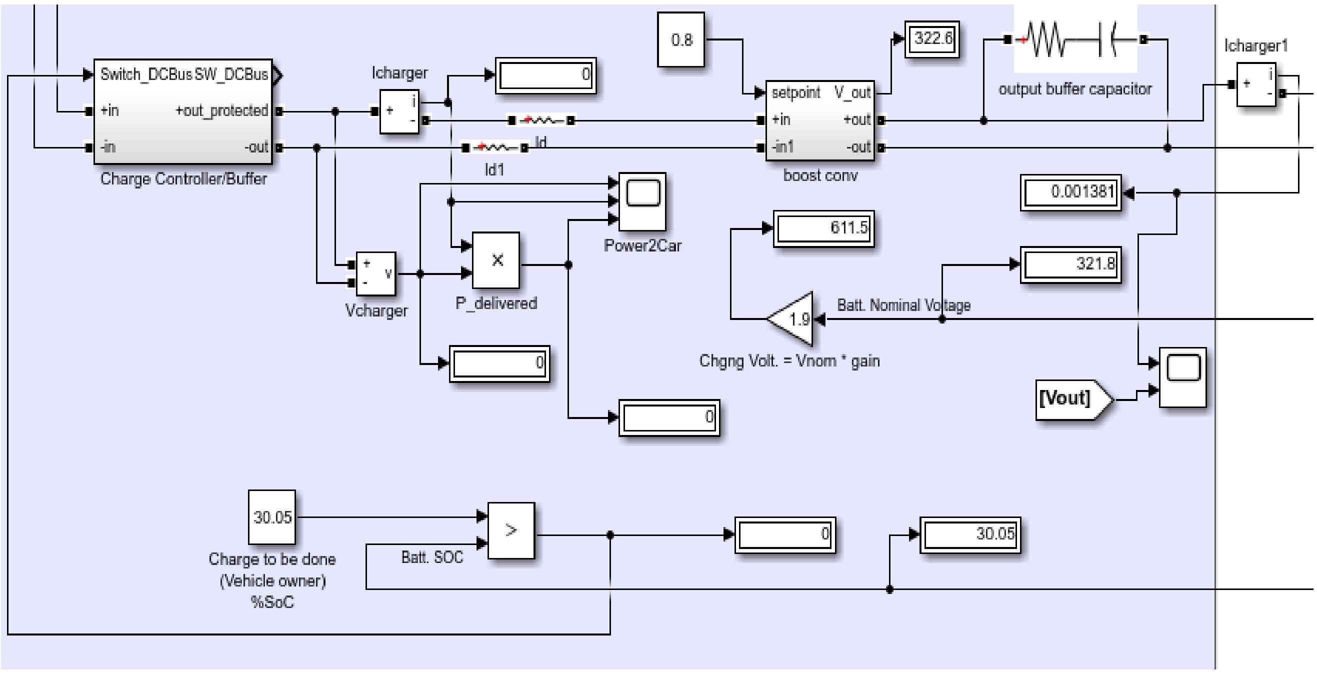

Figure 19: Charger Design Circuit

The adapter changeover is the initial section, after evaluations and other columns on the EV car's battery half. Two of the channels are only for DC power, while another eight are for dc-link and stage of full or SoC output.

The SoC line is compared to the user-defined setpoint (such as charging the vehicle to 60 percent). If the SOC of the battery is less than the setpoint, the control signal is set to high, the switching block or charge controller is turned on, and the EV obtains energy. The control gets low and charging stops when the SOC set on the EV side is reached. This code is used to simulate a microcontroller adjusting a charger's SOC target or a user setting the SOC after paying at a commercial charger.

A DC-DC boost converter is utilized because the energy storage technologies' energy is frequently higher than that of the cushion bank or the SPV matrix outlet. The increasing output necessary is set here by the controller. We adjusted it in this case so that the output functions in discontinuous conduction mode, which allows for high current pulse charging. This method is not quick, but it does enhance the charging rate.

To make the simulation brief, the modeling SOC objective is set to be 0.05 greater than the real Energy storage system SoC.

The boost converter is seen in the diagram below.

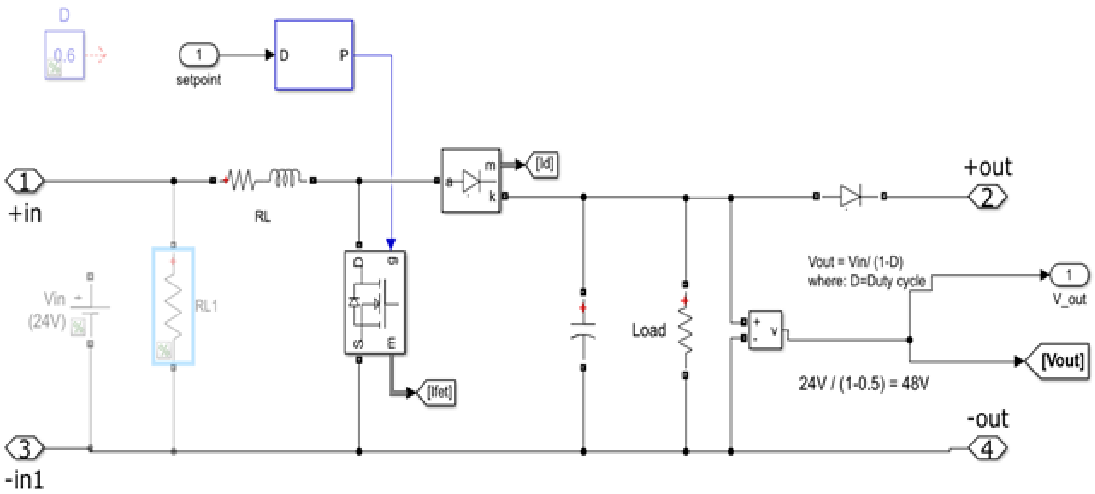

Figure 20: Boost Converter

The boost voltage on the output is given by the following formula.

Vout = Vin/(1-k)

Were,

Vout is the output voltage,

Vin is the input voltage,

K is the duty cycle for the switching device.

On the output side, another capacitor buffer is used to smooth out the pulses and a current sensor is placed for monitoring energy flow.

The next part is the EV battery itself;

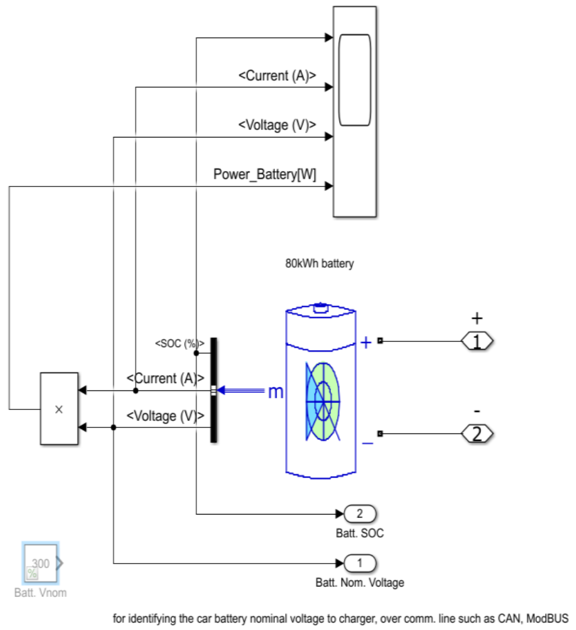

Figure 21: EV Battery Circuit

Note that the charge is rated at 80kWh, making it a high-end EV car by today's standards, as low-end electric cars have batteries rated at less than 50kWh. The output lines for SOC and Voltage are also visible. They are usually standardized and based on protocols like CAN (controller area network), which is widely used in the automobile sector because of its reliability.

The configuration is shown below;

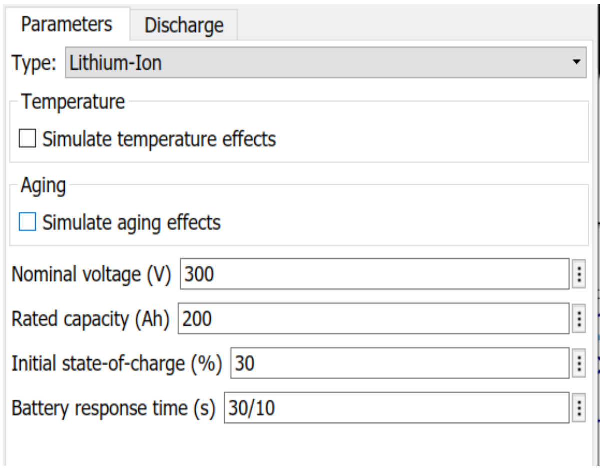

Figure 22: Configuration

VI. SIMULATION AND RESULTS

Starting with the SPV;

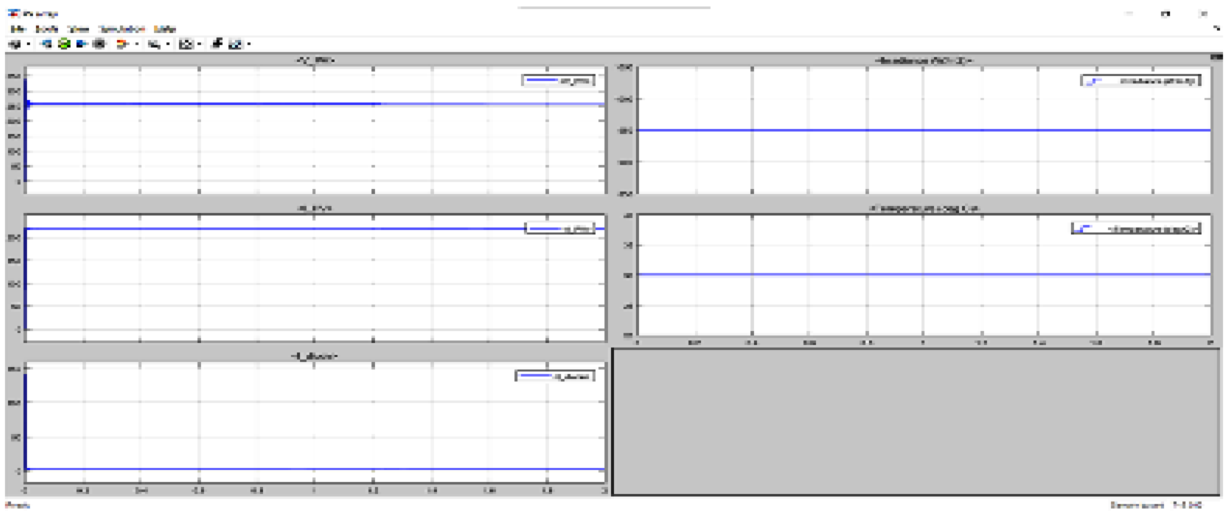

Figure 23: SPV

In this situation, the current and power are with MPP.

The DC bus within the charger has the following voltage:

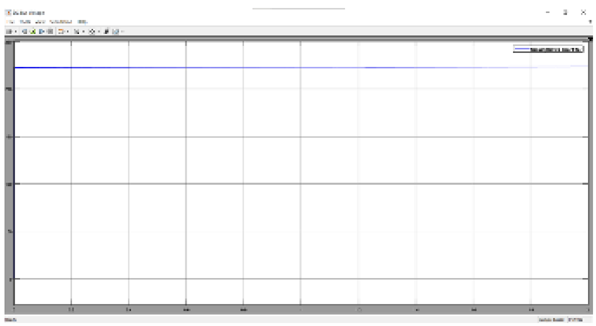

Figure 24: *DC Bus Voltage*

The storage battery inside the charger is shown;

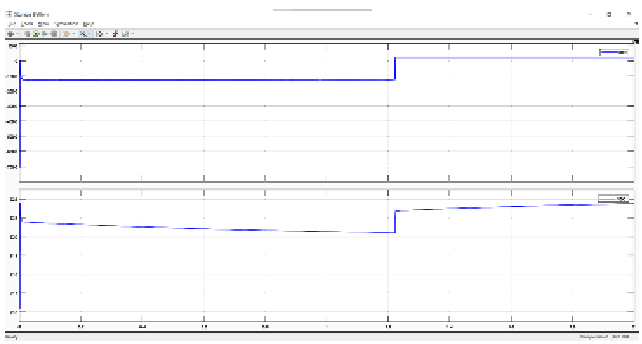

Figure 25: Storage Battery Inside the Charger

Because the SPV is also charging the EV battery, the negative current indicates that it is discharging, as does the drop or decrease in the voltage.

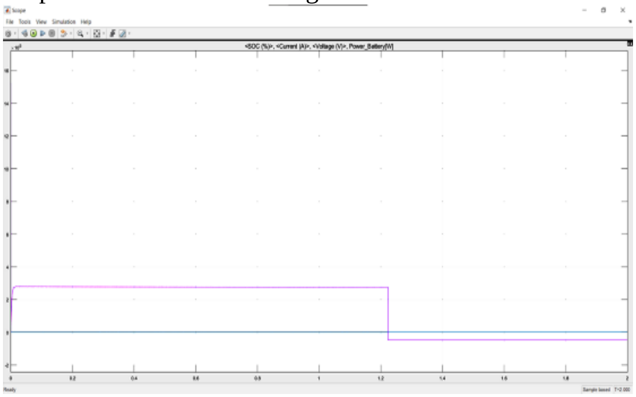

Figure 26: Drop and increase of Voltage effects

The duty cycle is depicted by the purple curve, which has the end la as its vector. amplified by 105. The negative power indicates that something is charging.
After the power converter, the force going to the car is shown;

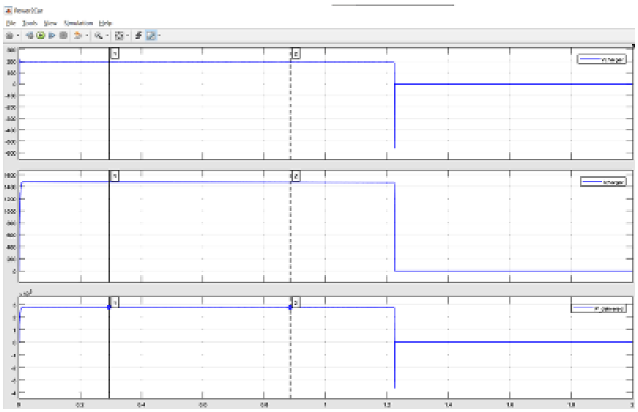

Figure 27: Power Divided

The V charge comes first, second by the I charge, and finally, the Power provided. The voltage, current, and power are all 0 when the charger is turned off.
The actual current flowing to the electric vehicle battery is as follows:

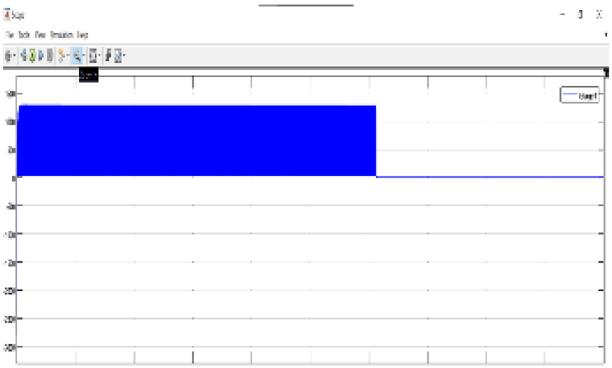

Figure 28: Current in the battery

The same when zoomed in;

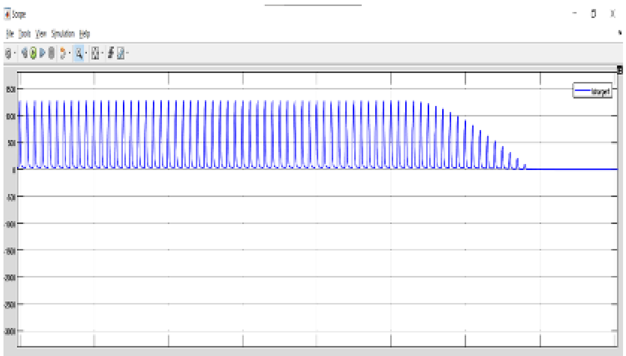

Figure 29: Zoomed picture of the current curves

Note the high current pulses.
The battery characteristics for electric vehicles may be found on the following page. The SOC rises till it reaches the desired level. Because the battery is charging, the current is negative, and the voltage exhibits 20V changes that were employed to produce the pulses. This is reflected in the amount of electricity provided.
The reverse flow protection in the boost converter of the charger stops the battery from discharging in proportion when SOC hits objectives.

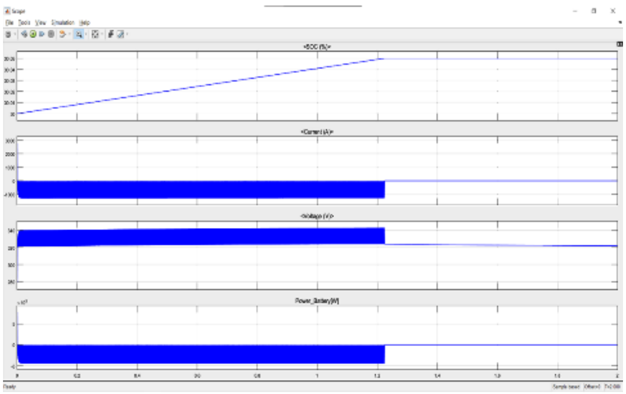

Figure 30: Reverse flow protection

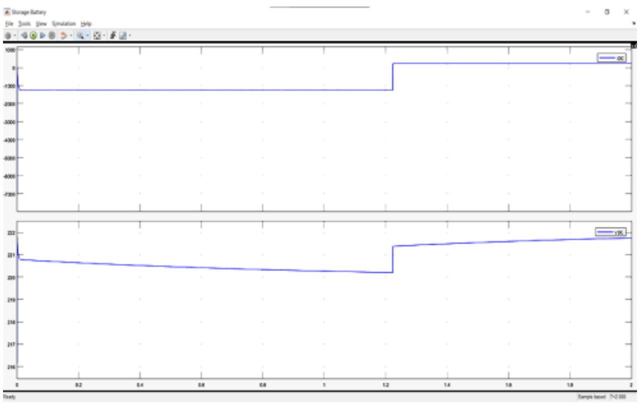

Figure 31: SPV Energy

When the EV pack is discontinued, the gas from the SPV is redirected to the converter charge, which resumes charging; this can be seen in the diagram, which exhibits the charger voltmeter increasing.

VII. CONCLUSION

The primary goal of providing a design and modeling it in Simulink was met, and the results demonstrated that the concept is functional. The SPV integration for a solo EV charger also appears to be promising. The charge controller, power monitoring and feedback, as well as pulsed charging, all performed admirably.

This research proved that a workable design for SPV-based electric car charging is a realistic option. Additional work might be done to expand the simulation to a multi-vehicle situation, reduce losses, and improve vehicle-charger communication, among other things

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