

EV Charging Using DC Storage and Sustainable Energy

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ABSTRACT- As countries and automakers focus on initiatives such as "keeping green," climate action, and so on, the present worldwide inclination favoring electric vehicles is growing. An inherent aspect of this is the design of electric cars. Electric automobiles run on energy provided by a power source, which is often batteries. These batteries must be recharged. As a result, a charging station must be available. Various generators are converted into Electrical output for the car at public charging or terminals. As countries and automakers focus on issues such as "being green," climate action, and so on, the present worldwide inclination favouring electric vehicles is growing. The fact that there is a major source of this is a major element of this system of electric cars. Electric automobiles run on energy provided by a power source, which is often batteries. These batteries must be recharged. For this As a result, a rechargeable battery is required. Various generators are converted into Useful electricity for the car at public charging or terminals.

KEYWORDS- DC Storage, Electrical automobiles, Batteries

I. INTRODUCTION

Electric automobiles were originally introduced in the late 1800s but were swiftly eclipsed by electrically driven engine-powered vehicles introduced in the early 1900s. This happened as a result of shortcomings and outdated batteries.

To started with, as the efficiency of PV frames has reduced, the use of various energy such as solar lighting seems to be more accessible to a wider audience [1]. Steel mills and offices in the Uk have a lot more potential for renewable (PV) panels because of their large footprint on flat rooftops. Examples include warehouses, industrial buildings, institutions, factories, and other structures. This potential is now mostly untapped. Second, as compared to fuel cars, EVs provide a clean, energy-efficient, and noise-free mode of transportation. In 2020, the Netherlands is expected to have 200,000 electric vehicles [2]. As indicated in Fig. 1, this article investigates the possibilities of constructing electric car charging PV panels are used in the structure. The system is designed to be used at offices to charge members' electric vehicles even if they are placed for the day. The objective is to maximize PV energy use for Fuel cells while reducing grid transfer of energy.[3]

EVs become a feasible alternative once more with the development of more sophisticated lithium-based energy storage reactors. Electric vehicles are expected to totally

replace current electric engine (ICE) generation in the near future.

by the end of the century. However, because the grid's energy consumption is relatively high, the electric grid and producing sources would be significantly stretched if these automobiles become more prevalent.[4] These issues will erode generator spinning reserves, which are already low, as grid managers transition to smart reserves in order to better maximize power generation of generating facilities. Because electric vehicles will eventually replace internal combustion engines, tens of millions of EVs will require charging. The energy necessary to charge them cannot be gained only through current capacity.

Advancement designs, rooftop solar, and solar energy consumption are just a couple of minor options.[5]

Alternative sources is especially critical as it's the third major source of power that has not yet been fully used. This research will employ a simulate in Simulation results, a block scripting component of Section usually' MATLAB software, to investigate the utilization of photovoltaics.

The simulation will comprise a charger, a solar array, a storage battery for the charger, and a battery to replicate an EV battery.

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

A process global temperature is just being blamed for the substantial shift in atmospheric circulation during the previous hundreds of years. This, thus according to academics, is attributable to to changes in human technology, specifically increased emissions of chemicals like carbon dioxide and nitrogen oxides that trap heat in the atmosphere [1-2]. Renewable energy has been promoted as a means of reducing the effect by decreasing hazardous gas emissions into the atmosphere. The energy systems based on wind and sun are particularly intriguing. As people work to manage, develop, and run these new energy resources, they will be able to find new jobs. Renewable energy sources have also become more affordable over the previous decade.[6]

Because the sun is the planet's greatest source of energy, with over 100 TWh of energy received, we're looking into solar photovoltaic (SPV)-based charging. The increased

number of electric vehicles on the road can reduce grid stress dramatically. [12-13]. a potential replacement for current electrical generation technologies [3]

The concept of using sustainable energy to charge electric vehicles is not new. On the other hand, the recharge design still must be extensively evaluated.[7] They looked at the effects of global warming on the use of renewables for charging, as well as the locations, timings, and effects of global warming about use of renewables for charging. [4-10]

Previously, research focused mostly on improving the efficiency of conventionally obtainable forms of energy for ev charging, such as electrical generation, hydro, and so on. [8] [11]

IV. METHODOLOGY

Solar PV, or solar photovoltaic, systems use incident On precisely developed panels composed of tailored silicon, sunlight is converted into power. This device captures photon energy to make charge pairs, which are then pushed to flow via an open circuit pathway to create electricity. PEE is a cost effect that stands for light reactions.[9]

Because of improved manufacturing technologies and cost savings, the usage of these panels has increased, because they've become more affordable. Its application in rooftop solar, on the other hand, is still in its inception.[10]

A common panel looks like this, as shown in the figure below. Arrays with significantly higher power capacities are frequently created by stringing them together in series and parallel combinations.



Figure 1: Solar Panels

As seen in the preceding figure 1, several panels are mounted on steel columns to face the sun for best performance. Several of these structures are connected by wires to form massive arrays. A solar tracking array is shown in the image, which tracks the sun across the sky.[12]

A solar array installed on a parking lot that might be utilized for distributed generating is depicted in the Figure 2. With EV chargers taking power from this array, this design serves as the foundation for our simulation.



Figure 2: Solar Panel Array

The average of the voltage (achieved by the number of panels linked in series) and present (obtained by the numbers of panelists connected in parallel) may be used to calculate the power from an array.[13]

$$P_{array} = (n \cdot V) \cdot (p \cdot I)$$

Where;

n – is the number of panels connected in series

p – is the number of panels connected in parallel

V – is the voltage of a single panel (open circuit or maximum power)

I – is the current of a single panel (open circuit or maximum power)

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

A. Battery

Many different types of batteries have been used in electric automobiles, starting with lead acid batteries in the 1800s and advancing through lithium-based systems today.

Many lithium-based cells with a typical output voltage of 3V make up lithium-based batteries. To avoid injury, these batteries must not be discharged below a specific voltage level. [14]. Multiple of these to create a high-power system, charges are linked in series and parallel. Battery pack for an electric automobile. A charge controller, often known as a BMS, is a specialized regulator used to charge and assess the status of battery packs, cell groups, and even individual cells. The Figure 3 depict a typical EV battery pack and BMS.



Figure 3: EV Battery Pack

The vertices seem to be the cell stones, which contain many cells, and the purple cables connect these columns to construct the high voltage battery pack. [16].



Figure 4: Block BMS Board

This is a BMS board with a single cell block as shown in Figure 4. It oversees controlling and monitoring individual cells. Each building has its own management system (BMS). Power MOSFETS act as cell control switches and are represented by individual black squares in a line.[17].

B. Chargers

Electric vehicle chargers are a type of DC-DC converter in this architecture, similar to boost converters, buck converters, or other DC-DC topologies. This is because different electric cars utilize battery packs with differing

voltages and capacities. Figure 5 depicts a common EV charger.



Figure 5: The blue box with the wire is the charger.

Because they frequently handle high-speed charging, which can consume power in the kiloampere range, industry point charger cables are thick. Pulsed charging is used in this paper's notion to remain ahead of a DC-to-DC converter's conduction mode[15]

V. SYSTEM ARCHITECTURE

The simulation design and results produced in MATLAB Simulink are now explained. Figure 6 below shows the entire simulation design.

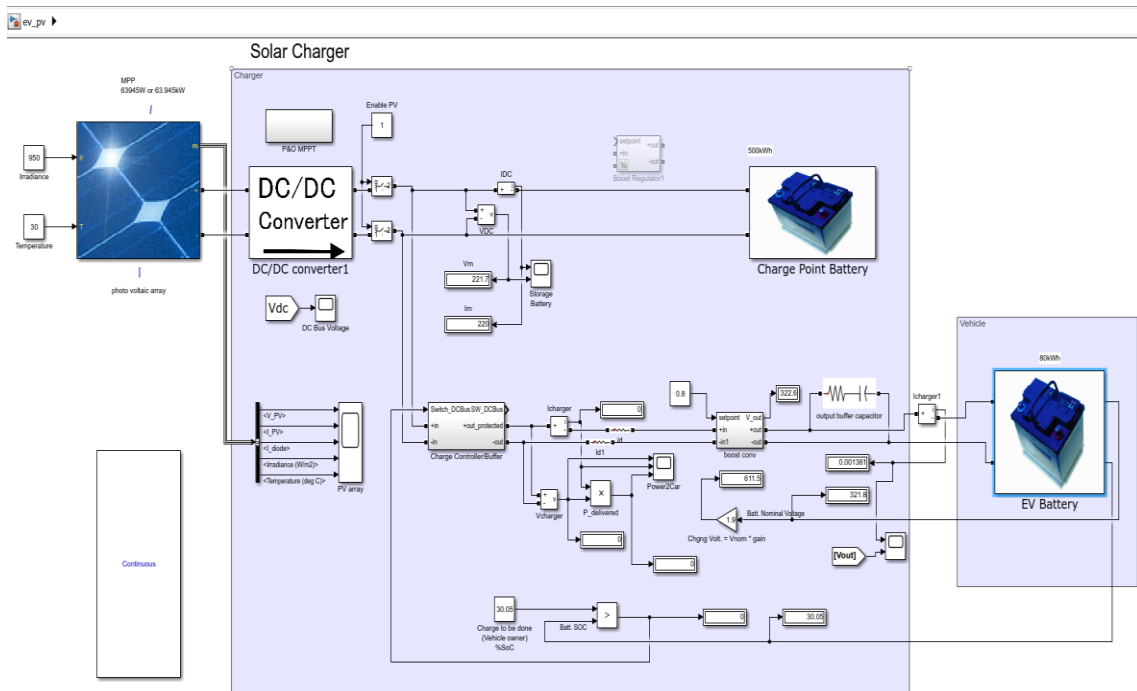


Figure 6: Simulation Design

In the upper left corner, there is a solar array block. The electric car battery is on the right, while the charger is in the centre. The charging station's buffer battery is

positioned in the center block. A more detailed image may be seen Figure 7

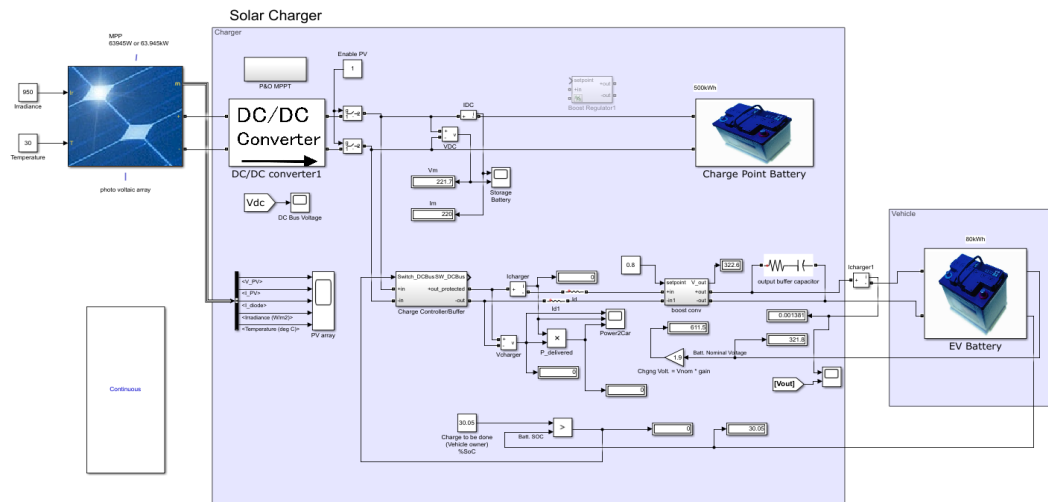


Figure 7: Simulation Circuit

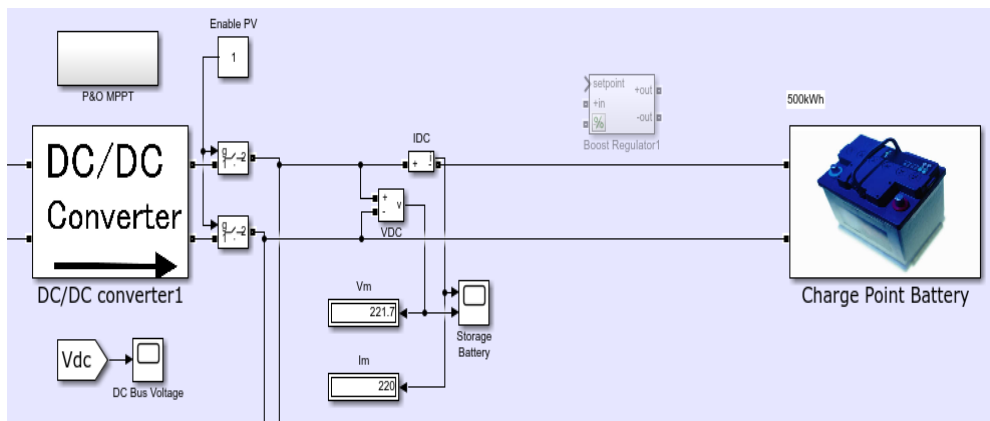


Figure 8: Solar Part of the Simulation

Figure 8 shows the solar Part of the Simulation

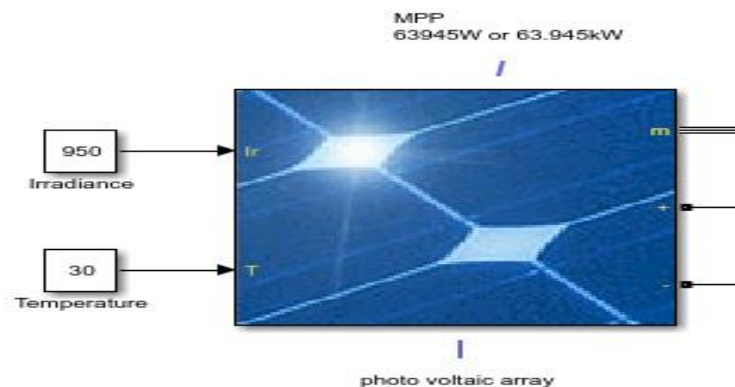


Figure 9: PV Array

Figure 9 shows MATLAB solar array bloc that can generate a maximum of 63.94 kW of power. The temperature is set at 30 degrees Celsius, and the warmth is set to 950W/m2.

To collect, maximum power from the panel, maximum power tracking often known as "P&O" or perturb and observe, is utilized.

This is accomplished with a specialized DC-DC boost converter, as seen in Figure 10 .

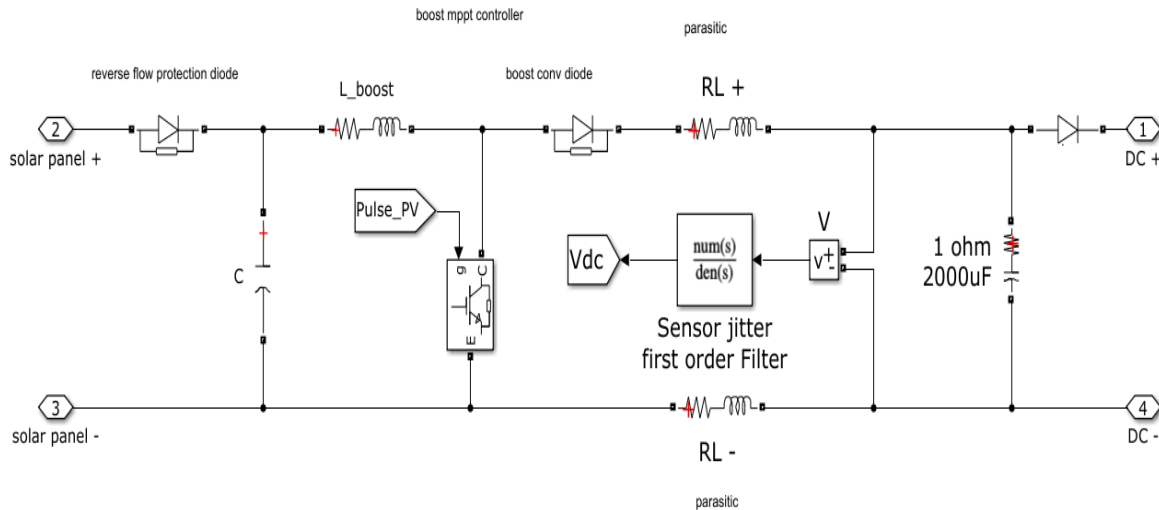


Figure 10; DC-DC Boost Converter Usage

The diodes ensure, no reverse flow of current.

State flow block modeling is used to implement the MPP approach, as demonstrated in figure 11.

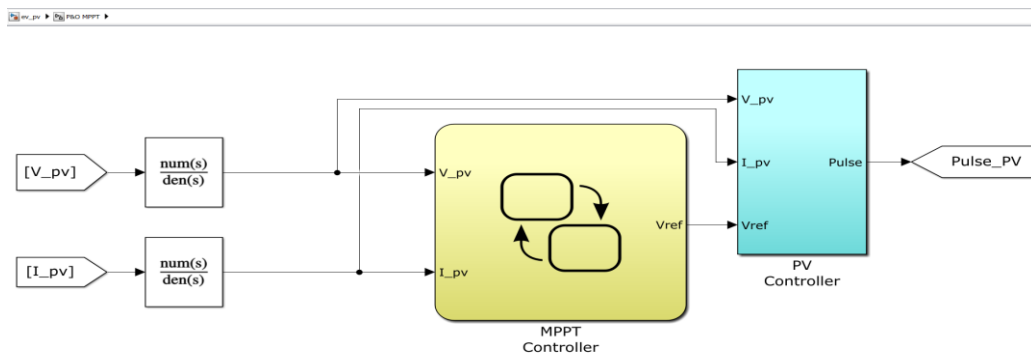


Figure 11: Logic Circuit

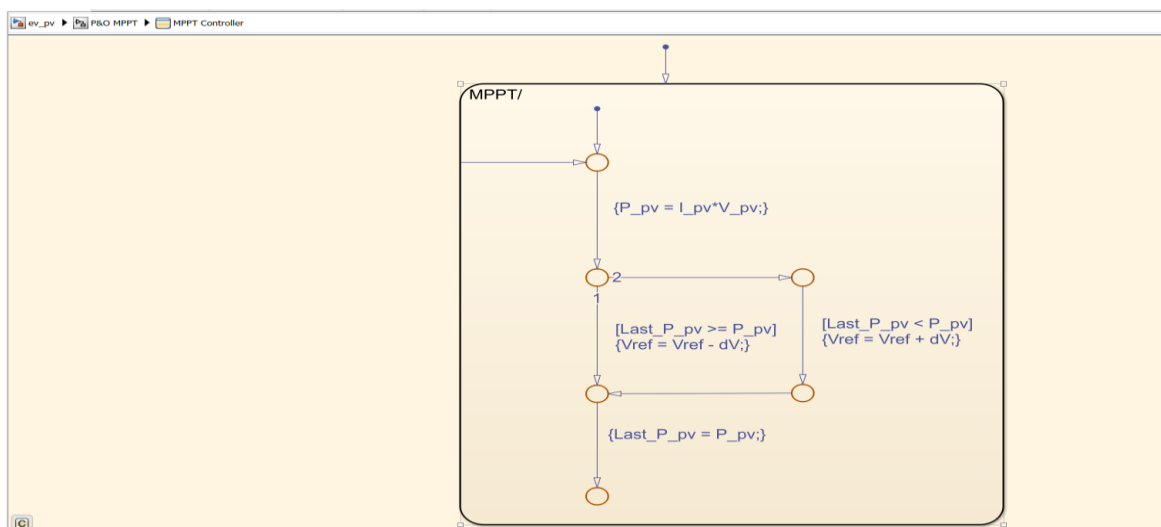


Figure 12: MPPT

To achieve a peak or maximum power from the subsequent voltage steps, the controller continually chases the higher of the two powers as shown in figure 12.

The regulated pulses, often known as PWM, are formed in the following way as shown in Figure 13.

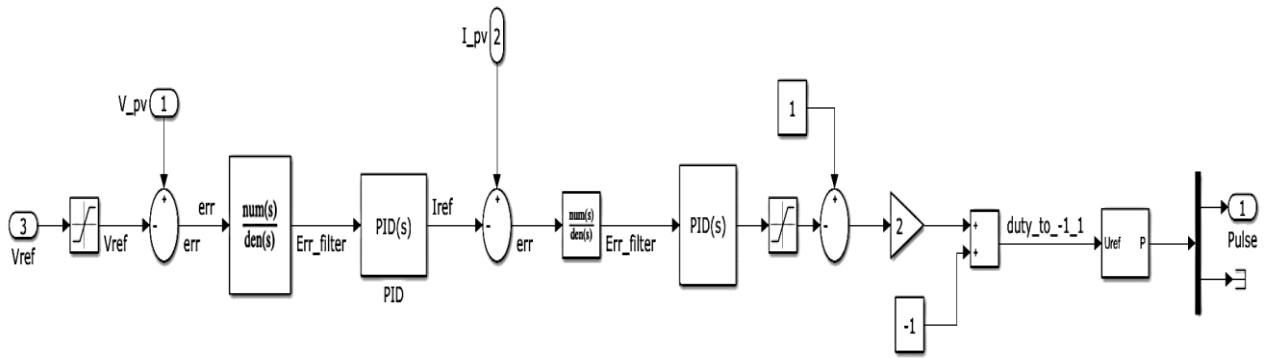


Figure 13: Power Paner Circuit

The power from the panel is controlled using two common control switches.as shown in Figure 14.

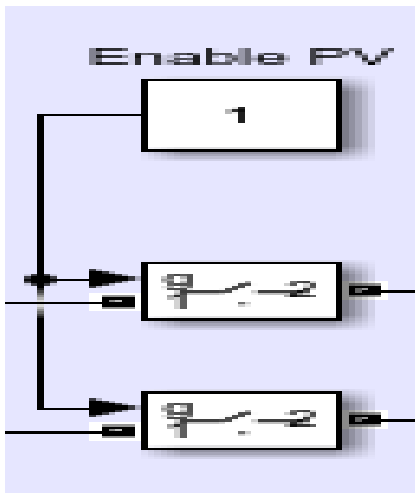


Figure 14: Control Switches

This can be used in cases of maintenance/protection purposes.

The buffer battery storage scheme is also shown in Figure 15 It has more ability to handle repeated charges for the same or different vehicles, as well as line losses. A specialized voltage and current gauge is used to product.

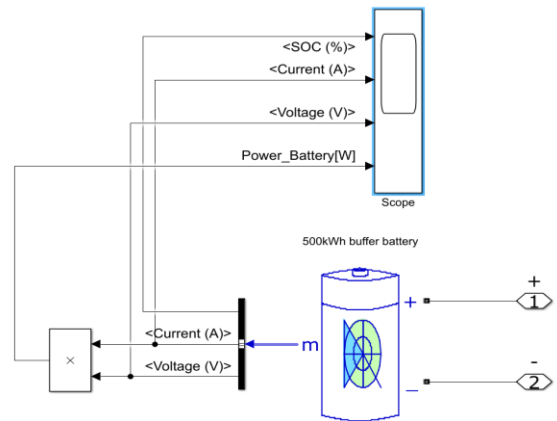


Figure 15: Buffer Battery

Another switch selection provides a control flow to the boost converter as shown in Figure 16 for the charger, which also features a dissipating capacitor on the output side.

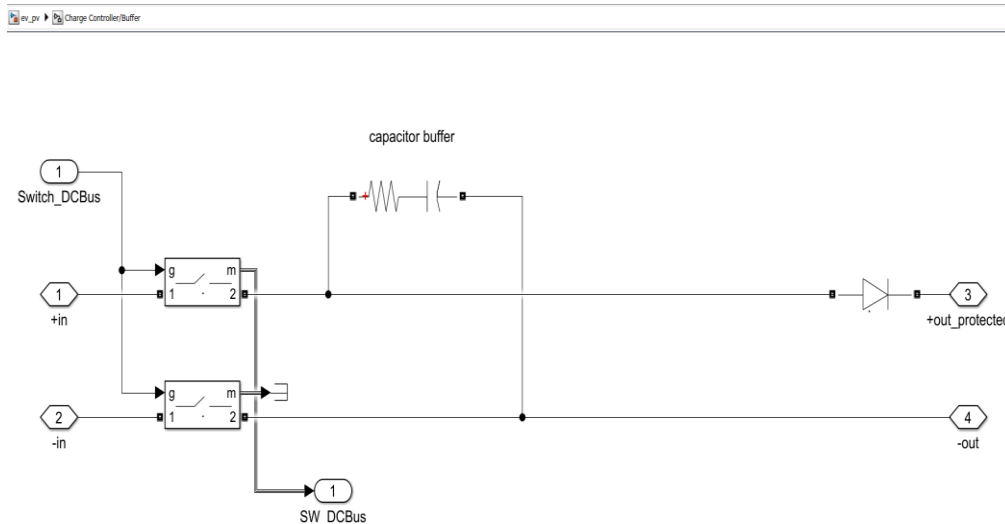


Figure 16: Control Flow Switch

V_{out} is the output voltage,
 V_{in} is the input voltage,
 K is the duty cycle for the switching device.

A capacitor buffer is employed on the output side to smooth out the pulses, and a current sensor is utilized to measure energy flow.

The EV battery is the next component as shown in figure 19 .

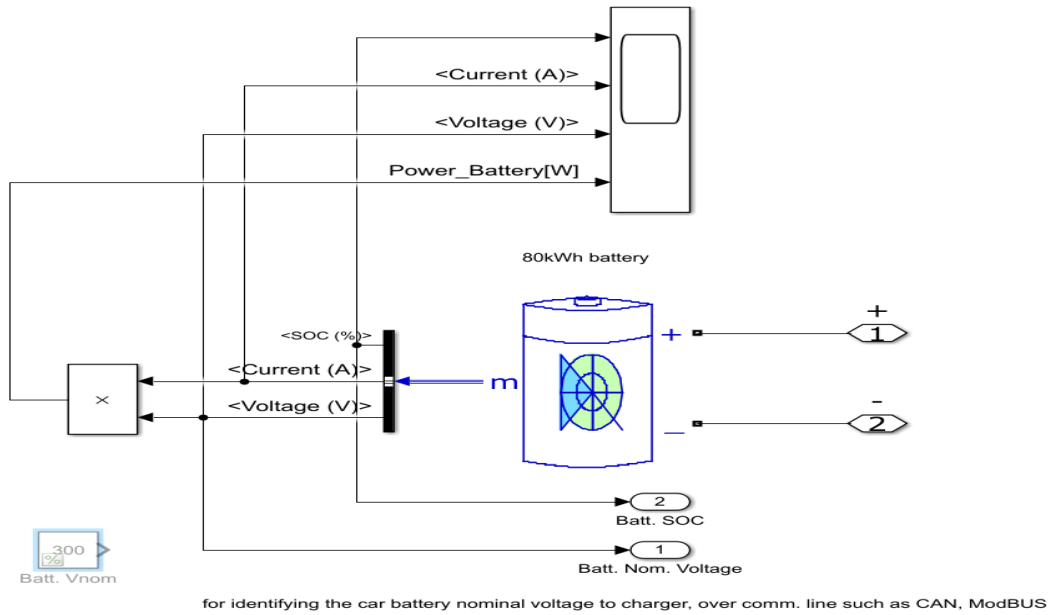


Figure 19: EV Battery Circuit

The charge is rated at 80kWh, making it a high-end electric vehicle by today's standards, while low-end electric vehicles have batteries rated at less than 50kWh. SOC and Voltage output lines are also visible. They are often standardized and based on protocols such as CAN (controller area network), which is widely used in the automotive industry because to its dependability.

VI. RESULTS

Starting with the SPV; as shown in Figure 20. In this situation, the current and power are with MPP.

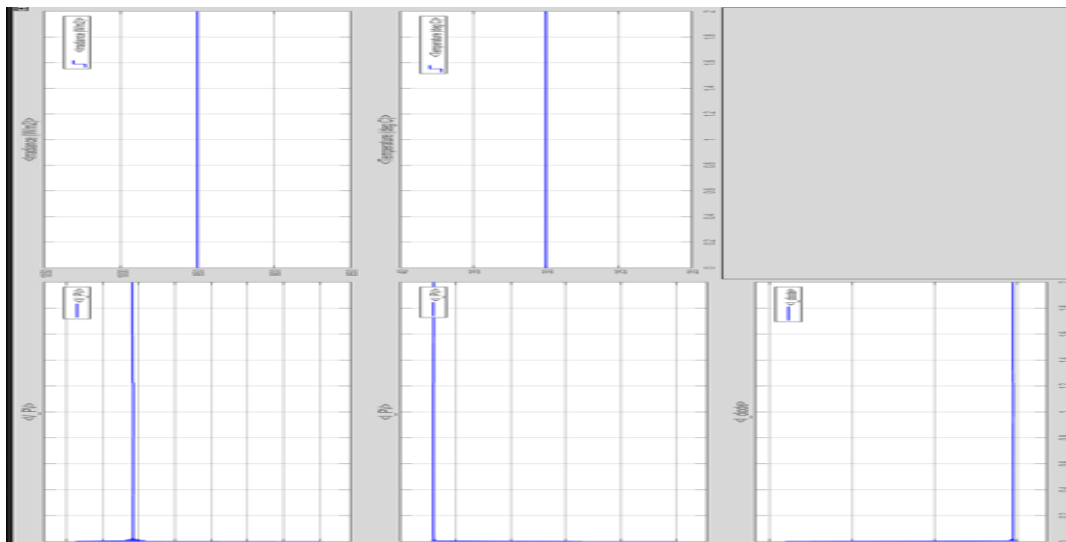


Figure 20: SPV

The DC bus within the charger has the following voltage as shown in the below Figure 21.

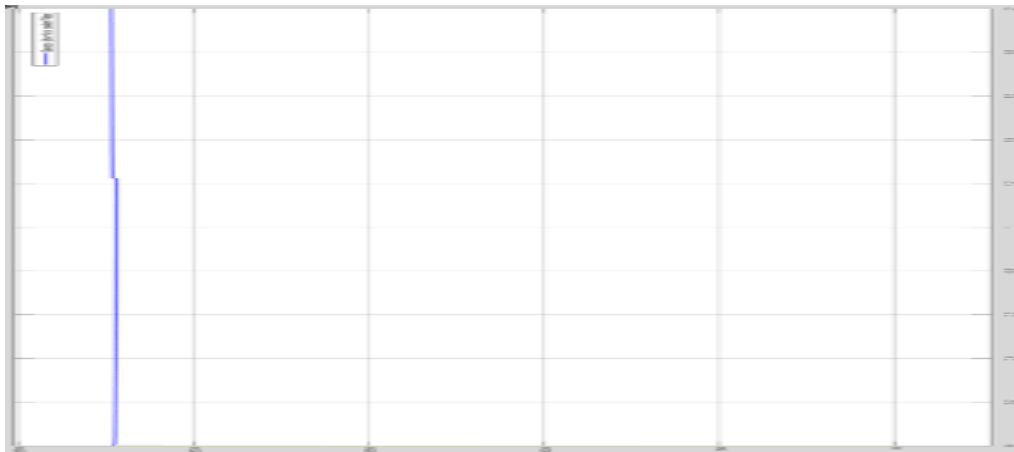


Figure 11: DC Bus Voltage

The storage battery inside the charger is shown in Figure 22.



Figure 22: Storage Battery Inside the Charger

Because the SPV is also charging the EV battery, the negative current, as well as the dip or reduction in voltage, indicate that it is discharging. Can be seen in Figure 23.

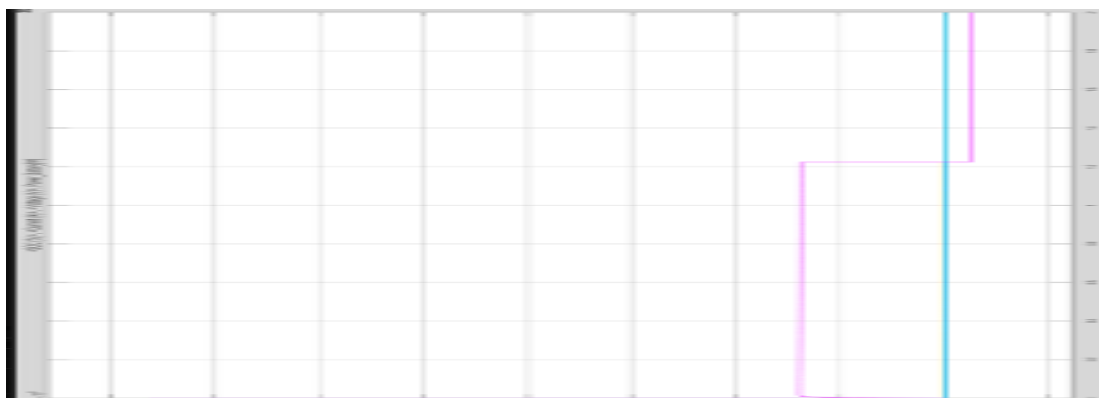


Figure 23: Drop and increase of Voltage effects

The power flow is depicted by the green curve, with the y-axis amplified by 105. Something is charging when the power is negative.

The force travelling to the automobile is displayed after the power converter; as shown in Figure 24.

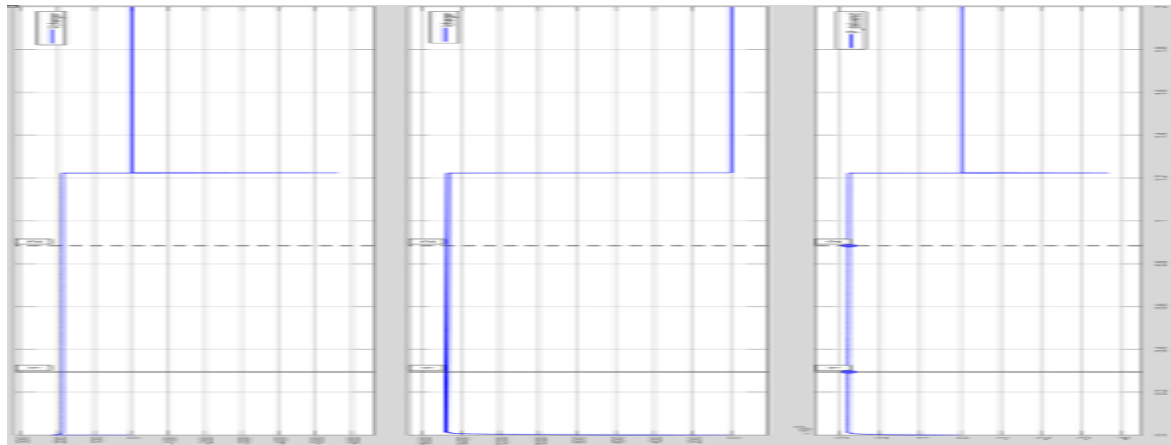


Figure 24: Power Divided

The V recharge comes first, then the I discharge, and finally the Power provided. The voltages, ampere, and power are all 0 when the adapter is turned off.

The current that an electric car's battery receives is as shown in Figure 25.

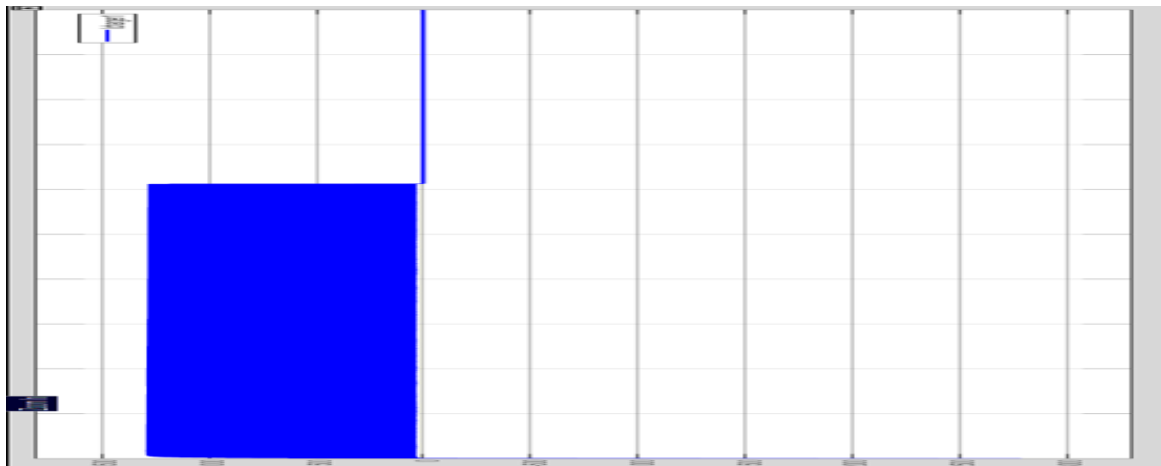


Figure 25: Current in the battery

The same when zoomed in as shown in Figure 26.

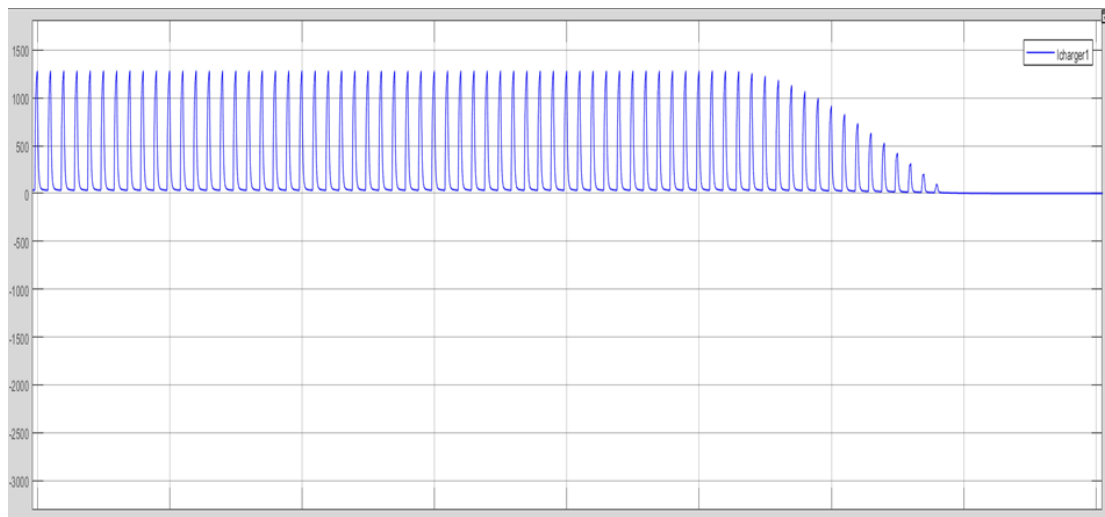


Figure 26: Zoomed picture of the current curves

Note the high current pulses.

The following page lists the battery characteristics for electric cars. The SOC climbs till the appropriate level is reached. The current is negative because the battery is charging, and the voltage shows 20V fluctuations that were

used to generate the pulses. The amount of power given reflects this.

When SOC reaches targets, the reverse flow protection in the charger's boost converter prevents the battery from draining in proportion as shown in Figure 27.

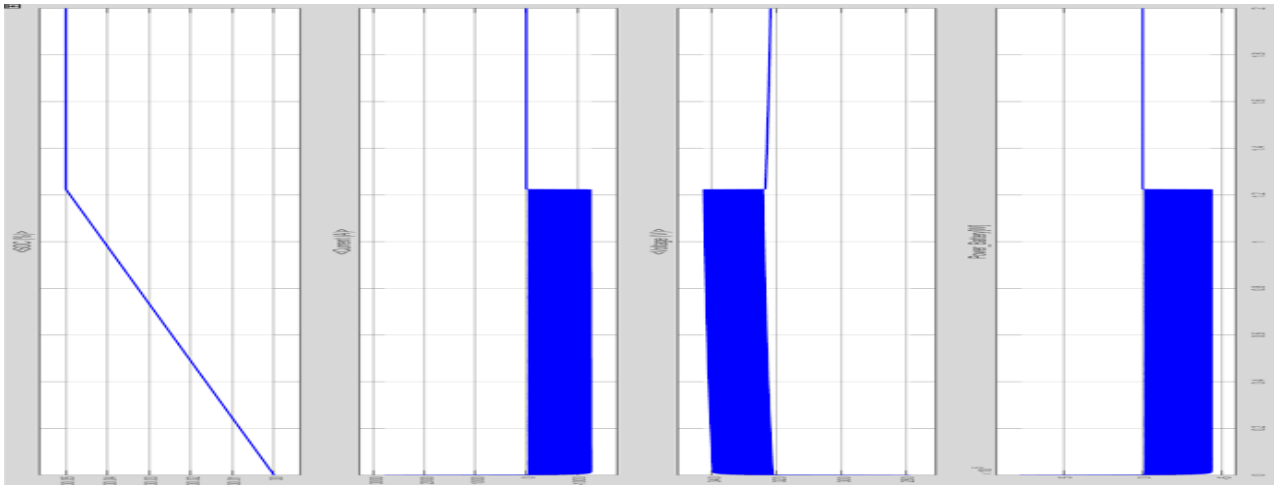


Figure 27: Reverse flow protection

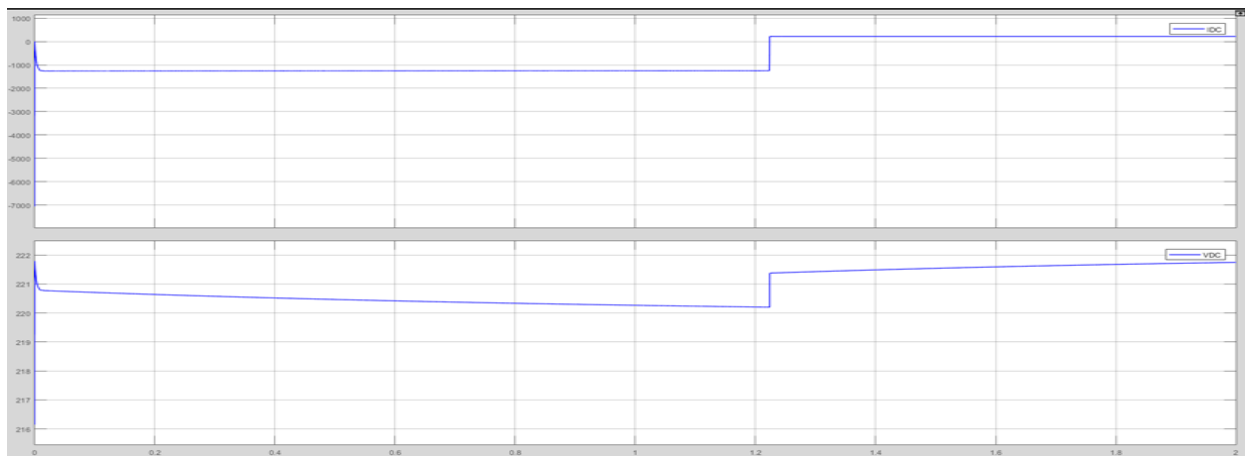


Figure 28: SPV Energy

When the EV battery is terminated, the energy from the SPV is redirected to the charger battery, which begins charging; this can be seen in the second graph of the Figure 28 which shows the charger battery voltage increasing

VII. CONCLUSION

The fundamental goal of generating a design and models it in Simulink was met, or the results proved the viability of such concept. The SPV integration for a single EV outlet also appears to be promising. Each and every constituent., including the charge controller, power monitoring and feedback, and pulsed charging, operated wonderfully. This study shown that a viable design for SPV-based electric vehicle charging is a viable solution. More work might be done, for example, to expand the simulation to a multi-vehicle situation, minimize losses, and enhance vehicle-charger communication.

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