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CLOSED LOOP BIDIRECTIONAL BUCK-BOOST CONVERTER FOR BATTERY

MITHULKIRUTHIK K S[1], KARTHICK K[2], KIRITHARAN C[3], N.RISHIKESH[4]
[1, 2, 3] UG- DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING, BANNARI AMMAN INSTITUTE OF TECHNOLOGY SATHYAMANGALAM.
[4] ASSISTANT PROFESSOR, DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING, BANNARI AMMAN INSTITUTE OF TECHNOLOGY SATHYAMANGALAM

ABSTRACT:
Charging and discharging batteries A DC bus (with a constant voltage), a battery, a common load, and a bidirectional two-switch Buck-Boost DC-DC converter are used here.1- The control of battery charging as well discharging is based on using PI controllers 2- The other is for battery current regulation. The presented case study includes two modes of operation: 1-Charging mode: automatically activated when the DC bus is connected and the control objective i.e.: set point (of the PI closed loop) becomes the full voltage of the battery. 2-Discharging mode: automatically activated when the DC bus is NOT connected and the control objective (of the PI closed loop) becomes load voltage to maintain the constant load voltage during discharging. In control topology, a distinct control as well as pulse width modulation (PWM) system is created for each mode of operation using the voltage feedback control strategy.
This method of charging and discharging can be used in a vehicle to grid and grid to a vehicle (here vehicle is considered as battery source/ DC source because of the same operation. Renewable energy can be used as a source to reduce pollution. The other mode of charging and discharging can be done with the help of solar as renewable resources to charge the battery. These are the way by which the closed loop buck-boost converter are been used for the battery operation.

KEYWORDS: Buck-Boost Converter, Battery, Controller, Charging/Discharging, renewable energy source.

1. INTRODUCTION:

Sustainable power sources are the most generally concentrated on electric power sources like breeze turbines and photovoltaic cells which are the most well-known inexhaustible sources. The photovoltaic model acquires an extraordinary consideration somewhat recently as it has not had a moving part and delivers less contamination to climate. The result normal for PV cluster relies upon boundaries radiation power and temperature. Expanding the temperature is diminishing the power created by the PV module at MPP. While an expansion in radiation force can cause expanding in the created power in the greatest power point of the PV Module. The PV cells work with the greatest result power and track the most extreme accessible result force of the PV cluster and make the PV framework more productive. In the industries, homes & Electric Vehicles (EVs) with onboard batteries are fit for supporting the network with enormous reconciliation of environmentally friendly power sources by engrossing (charging) the extreme measure of energy and returning it (releasing) to stack when required. The battery is considered to be a vital part of the system, which delivers the power during a power shortage time. The few types of batteries are Lithium-Ion (Li-On), Nickel-Metal Hybrid (NiMH), Lead Acid (SLA), and Ultra capacitor. For our project P1- lead acid is used and in P2- lithium is used. Lithium-particle batteries are as of now utilized in most convenient customer hardware, for example, mobile phones and PCs as a result of their high energy per unit mass compared with other electrical energy stockpiling frameworks. They likewise have a high ability to weight proportion, high energy proficiency, great high-temperature execution, and

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low self-release. The majority of lithium-particle battery components can be reused, but the cost of resource recovery continues to be a challenge for the industry. Charging And Discharging In Battery: The State of Charge depicts how full the battery is, as far as a percentage. Batteries charge quickest when they are almost unfilled — when they have a low SoC. The intensity or cool of the battery to keep it at the ideal temperature. In any case, EV batteries are impacted by the external climate. If it is hot outside, charging paces will be slower. If it's chilly outside, your charging velocities will likewise be slower. Batteries can decay and lose their charging limit over their life expectancy. How much power your EV battery gets in a charge is characterized by a unit of force called a kilowatt (kW). Furthermore, power (kW) is a result of voltage (V) and current (A). Both your vehicle and the charger have voltage and current cutoff points. The controller peruses the driver input signal and is responsible to deal with the framework energy, controlling the force and direction of the engine, battery pack, and the onboard charging frameworks. The controller gives every one of the essential functionalities like Battery state of charge (SOC) observing, Battery temperature observing & Overheating checking. Renewable Energy Source: By carrying out sustainable power inside an EV armada foundation, organizations and urban communities can additionally lessen contamination and their general carbon impression by bringing down ozone-depleting substance discharges from both the vehicles and the power plants. Beyond simply sun-oriented and wind power, other sustainable power sources incorporate geothermally, biogas, biomass, and low-influence hydroelectric. The Discrete PI Controller block performs discrete-time PI regulator calculation utilizing the error sign and proportional and integral gain inputs. The error signal is the distinction between the reference signal and the measured feedback. The block outputs a weighted amount of the input error signal and the integral of the input error signal.

2. SCOPE OF THE PROJECT:

AIM: To design a closed-loop bidirectional buck-boost converter for battery

The main objective of this project is: To design a charge and discharge controller for the battery. Environment-friendly, pollution-free, green energy. Optimization of battery performance. Helps in balancing electricity demand and avoiding unnecessary costs for an electricity system.

3. BLOCK DIAGRAM:

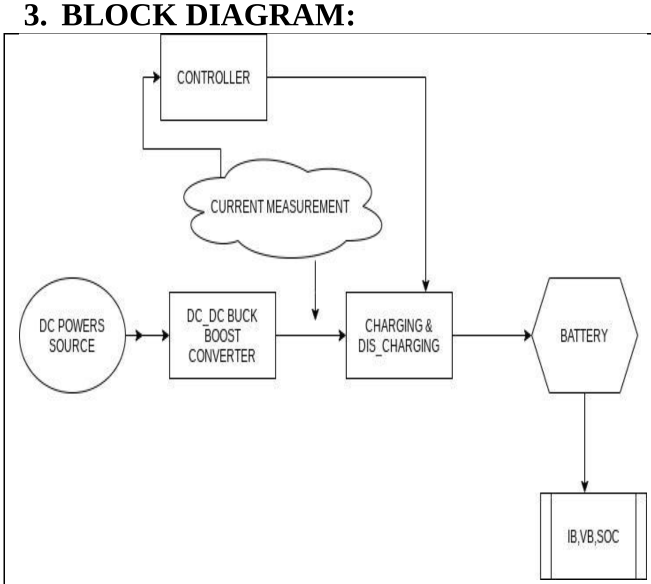

Figure 1: Phase-1(P1) of the designed project.

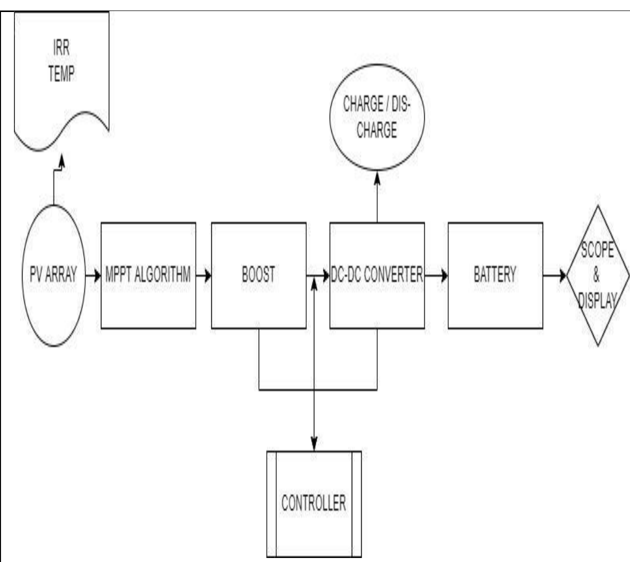

Figure 2: Phase-2 (P2) of the designed project.

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4. METHODOLOGY & RESULTS:

4.1) Phase 1 –Design and It's Working with the result:

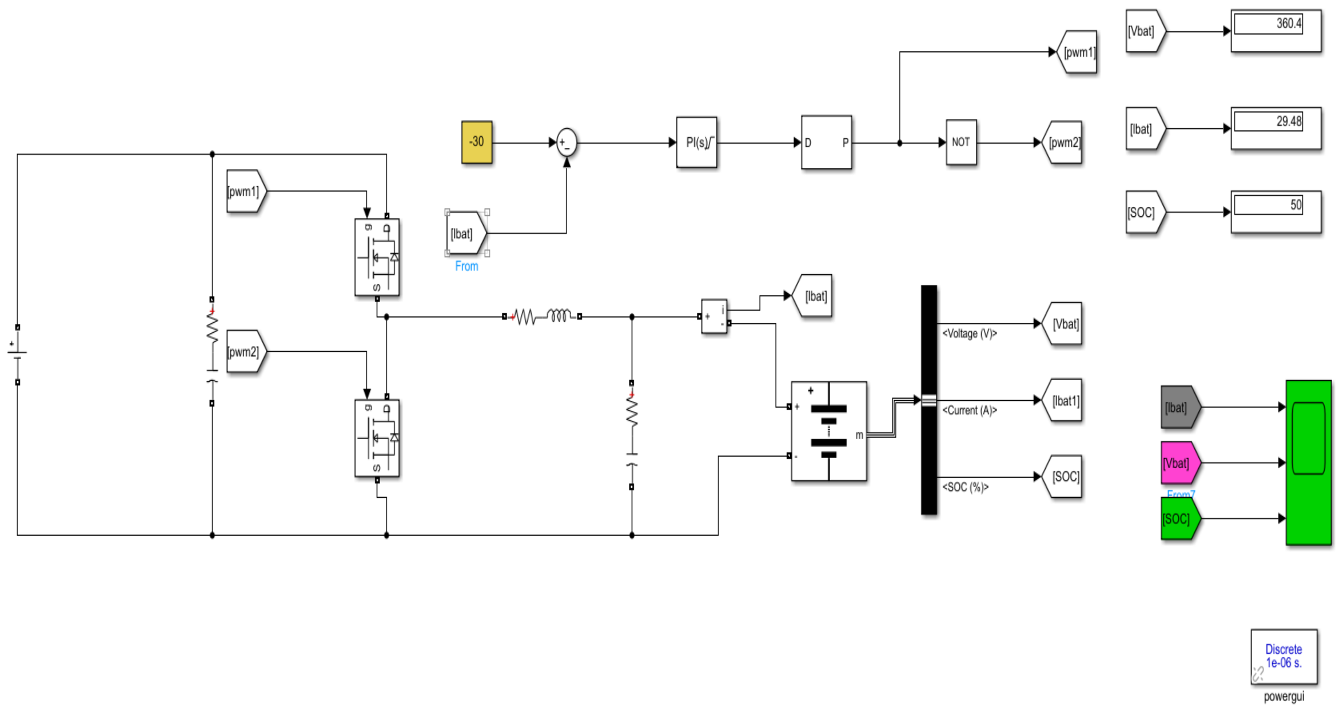

Figure 3:P1-Discharging mode-step down mode.

This is the **P1**consits of the buck-boost converter (bi-directional converter), here we have used the lead-acid battery and diode. The bi-directional converters can only allow the flow of current but also power in one direction, bidirectional converters allow the flow of current and power in both directions with the help of connecting two diodes in antiparallel with MOSFETs or IGBTs. Furthermore, bidirectional converters also can step-up as well as step-down the voltage following the requirements. Utilizing a capacitor to lower turn-off losses and an inductor to maintain operation, the bidirectional buck-boost converter is used to charge and discharge battery storage.

For the performance of the charging mode, the constant block is set up into the positive, and if we need the battery to operate in the discharging mode the constant block is set into negative. Hence all operation is powered with a constant dc source to charge the battery. As it stores energy during the ON mode and then provides energy during the switch-off mode, then it is in continuous mode. When it is operating in buck mode, the converter steps down the input voltage, which is primarily used to charge batteries because they require less power, and when operating in boost mode, the output voltage gets stepped up, which is primarily used to match load demand. From the battery, we have taken the connection of the Vbat, Ibat, and SOC. We are using the closed-loop control. .

These all mentioned (Vbat, Ibat1, SOC) are preset based on our needs. Here we are using the closed-loop control method with the feedback from the current (Ibat), thus it is taken from the current measurement block. Then it has been given as the input to the sumblock. The charging and discharging mode is controlled with the help of the PWM, which is taken from the diodes. For verifying the voltage, current, and state of charge the display as well the scope is also attached to verify the same. Below displayed are the Controller blocks for the Charging & Discharging operation. This is our (P1) first designed model of our project.

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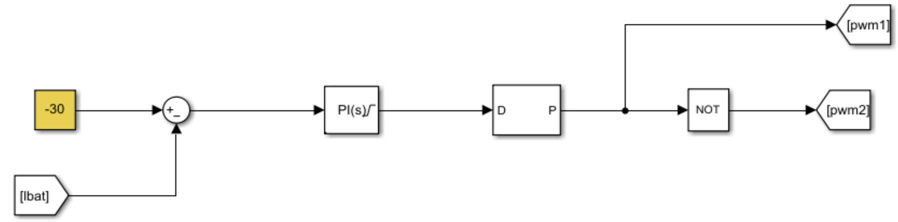

Figure 4: Closed-loop controller block connection

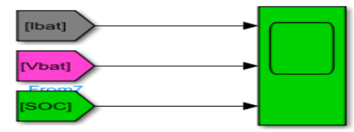

Figure 5:SCOPE CONNECTION WITH THE Ibat, SOC, Vbat

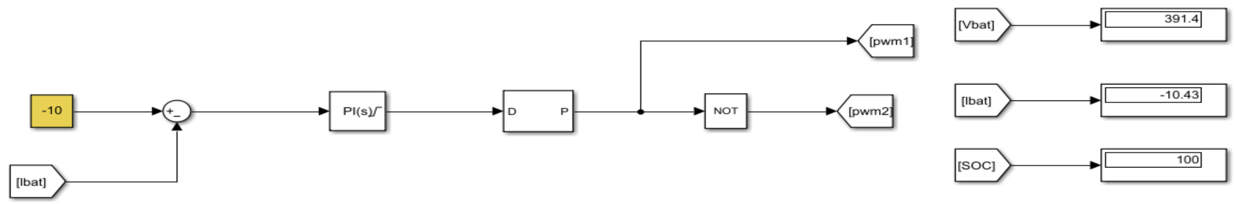

*Figure 6: Result of (**P1**)(the soc- 100%) – discharging mode*

This is the result after the simulation of the designed block, here we have fixed the current as the (-10) in the discharging mode. As per the given condition result is obtained, and all the values are maintained perfectly.

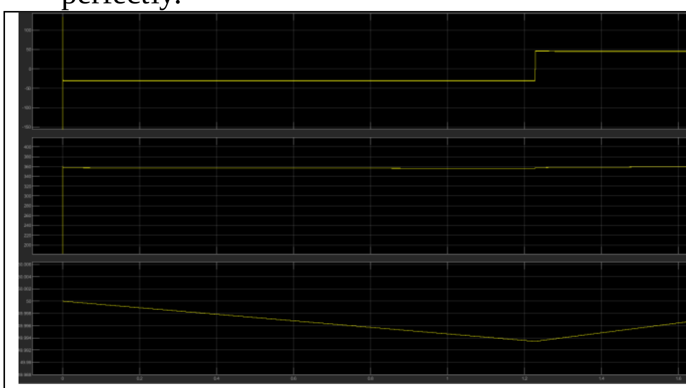

Figure 7: Scope output- at 50% SOC, Discharging(-30) to charging (45)

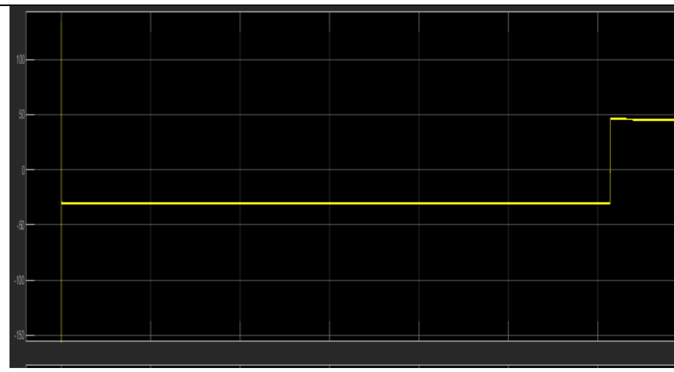

Figure 8: ZOOMED image – from discharging to the charging

Figure 9: From the charging to the dis- charging [50 TO (-35)]

4.2) Phase two design and working with the result

The above-designed (P1) and discussed model is upgraded (P2) with the help of a renewable energy source. This will replace the constant DC source of the previously designed model. Here we are using the PV array to generate the energy. The irradiance and temperature blocks are connected to the PV array. The power is boosted with help of the gate signals from the IGBT switch.

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We will be measuring the V (voltage) and I (current) in the boost converter, by which the BUS voltage and the PV current is being measured. The V bus and the IPV will be changing according to the irradiation. According to the output current will also be changing due to the change in the bus voltage.

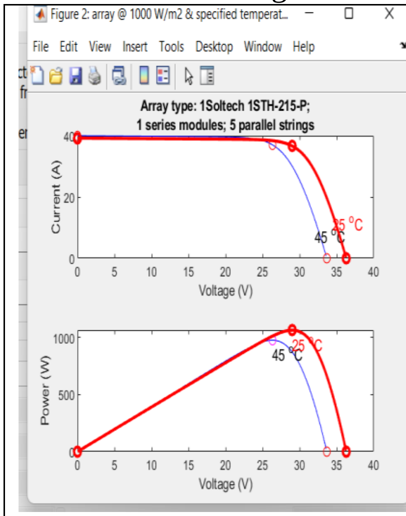

Figure 10: V & I of the PV array

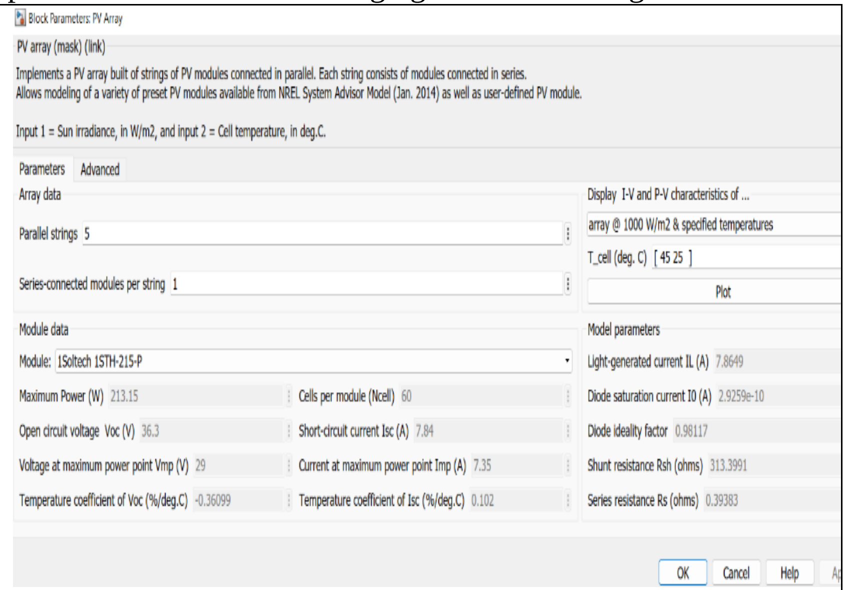

Figure 11:Block parameters of the PV array

integration_pv_FINAL_GOOD_WORKING ▶ MPPT1

```
function duty = MPPT_algorithm(vpv,ipv,delta)
% I used the MPPT algorithm in the MATLAB examples
duty_init = 0.1;
% min and max value are used to limit duty between
duty_min=0;
duty_max=0.85;

persistent Vold Pold duty_old;
% persistent variable type can be store the data
if isempty(Vold)
    Vold=0;
    Pold=0;
    duty_old=duty_init;
end
P= vpv*ipv; % power
dV= vpv - Vold; % difference between old and new voltage
dP= P - Pold;% difference between old and new power

% the algorithm in below search the dP/dV=0
if dP ~= 0 && vpv>30
    if dP < 0
        if dV < 0
            duty = duty_old - delta;
        else
            duty = duty_old + delta;
        end
    else
        if dV < 0
            duty = duty_old + delta;
        else
            duty = duty_old - delta;
        end
    end
else
    duty = duty_old;
end

%the below if limits the duty between min and max
if duty >= duty_max
    duty=duty_max;
elseif duty<duty_min
    duty=duty_min;
end
% stored data
duty_old=duty;
Vold=vpv;
Pold=P;
```

Figure 12: MPPT ALGORITHM

MPPT algorithms are commonly employed in the development of PV system controllers. The algorithms take fluctuating irradiation (light from the sun) as well as temperature into consideration to ensure that the PV system provides maximum electricity at all times. The Vpv, Ipv,Temp□Delta. As income to the **P1** design is employed at the right corner. This says that the same operation is carried out to regulate the charge and discharge according to the voltage reference & then the Kp and Ki value should need to be between 0 & 1 to obtain the result in the required manner.

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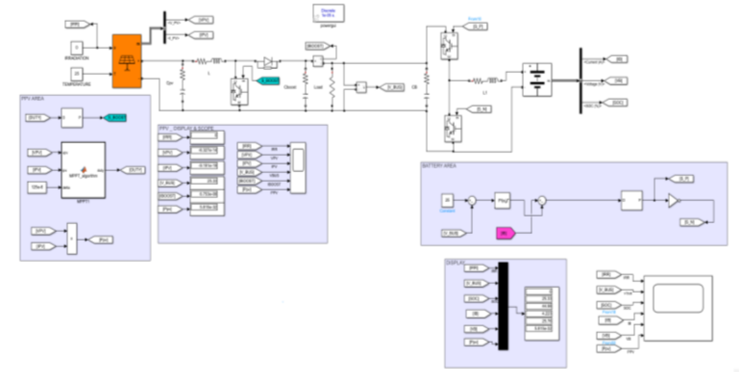

Figure 13: Phase-2 (P2) of the designed project

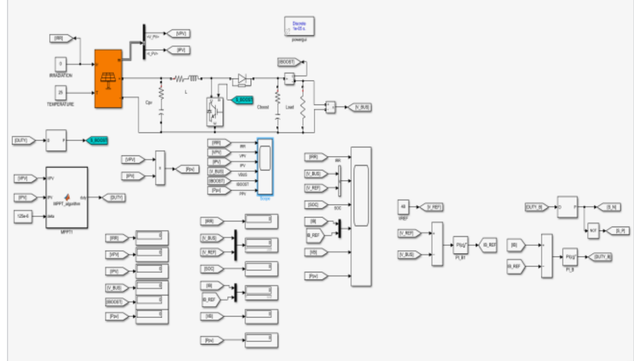

Figure 14:removed the DC-DC converter

From figure 10: To verify the model we have only removed the DC-DC converter and we have simulated and verified the results. The below output is all zero because the IRR value is given zero. Whether this is a condition during the rainy season or an impossible situation where the solar panel cannot produce power.

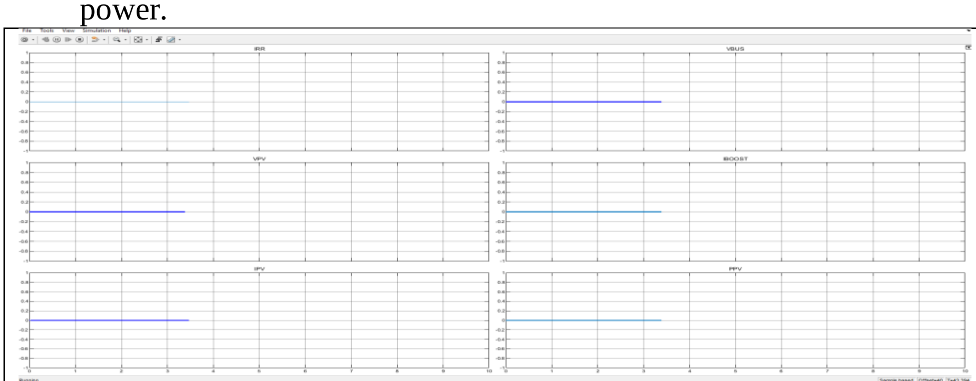

Figure 15: Scope result of the IRR=0

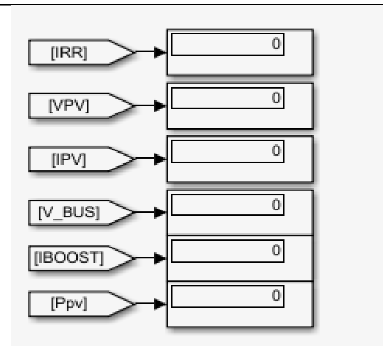

Figure 16: Display result of the IRR=0

TABLE 1: IR___level_ 0__ CONSTANT value = - 25 The below-displayed image is the irradiance level is zero and the output results are attached as the same. The below operation takes place in the discharge of the battery, and then the battery gets discharged by the rated voltage with the help of the controller in the pre-set values.

TABLE 2: IR___level_ 300__ CONSTANT value = 48 The below-displayed image is the irradiance level is zero and the output results are attached as the same. The below operation takes place in the charging of the battery, and then the battery gets charged by the rated voltage with the help of the controller in the pre-set values.

TABLE 3: IR___level_ 500__ CONSTANT value = 48 The below-displayed image is the irradiance level is zero and the output results are attached as the same. The below operation takes place in the charging of the battery, and then the battery gets charged by the rated voltage with the help of the controller in the pre-set values.

TABLE 4: IR___level_ 400__ CONSTANT value = 48 The below-displayed image is the irradiance level is zero and the output results are attached as the same. The below operation takes place in the charging of the battery, and then the battery gets charged by the rated voltage with the help of the controller in the pre-set values.

TABLE 5: IR___level_ 0__ CONSTANT value = -30 The below-displayed image is the irradiance level is zero and the output results are attached as the same. The below operation takes place in the charging of the battery, and then the battery gets discharged by the rated voltage with the help of the controller in the pre-set values and we can also see the battery state is been decreased during the discharge.

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Table 1:IRR-0

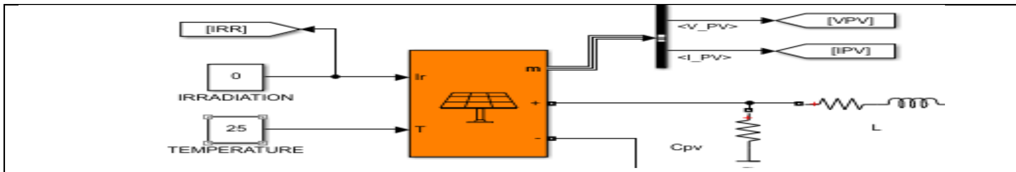


Figure 17:PV block- IRR-as 0

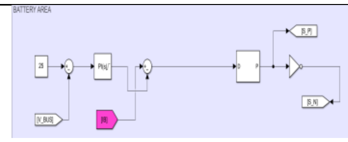
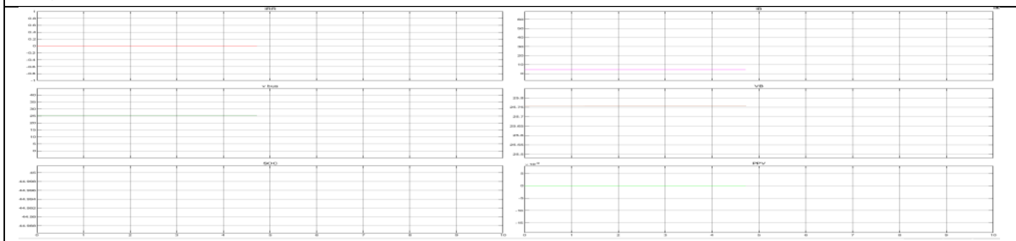


Figure 18: constant value as 25



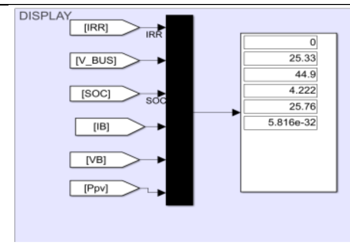


Table 2: IRR-300, and its output

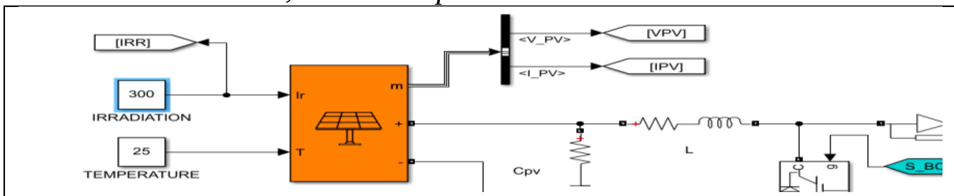


Figure 19:IRR-300

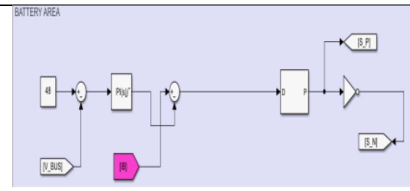
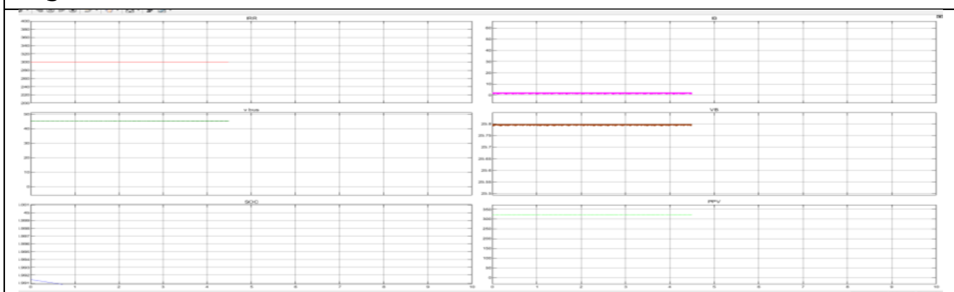


Figure 20: constant value as 48



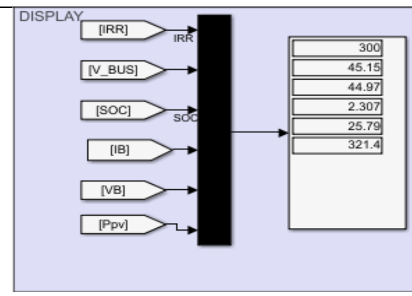
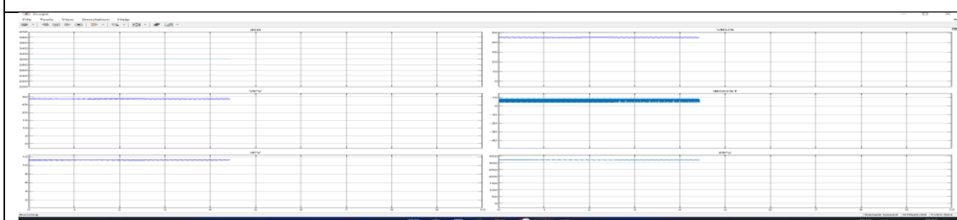


Figure 21: battery area display



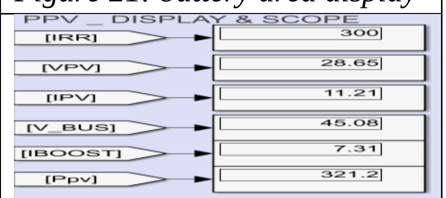
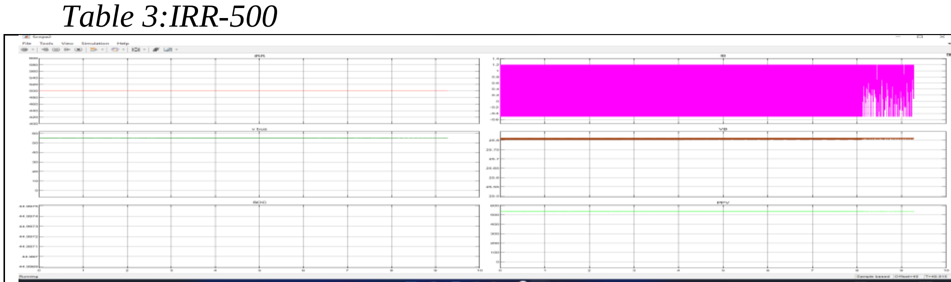
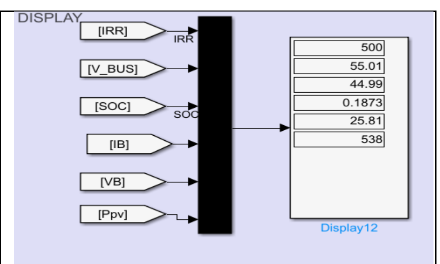


Figure 22:PPV_display

Table 3:IRR-500





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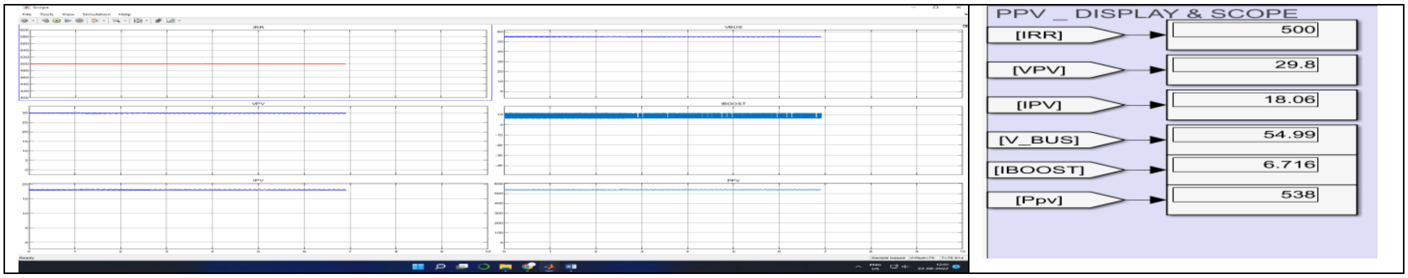


Table 4:IRR-400

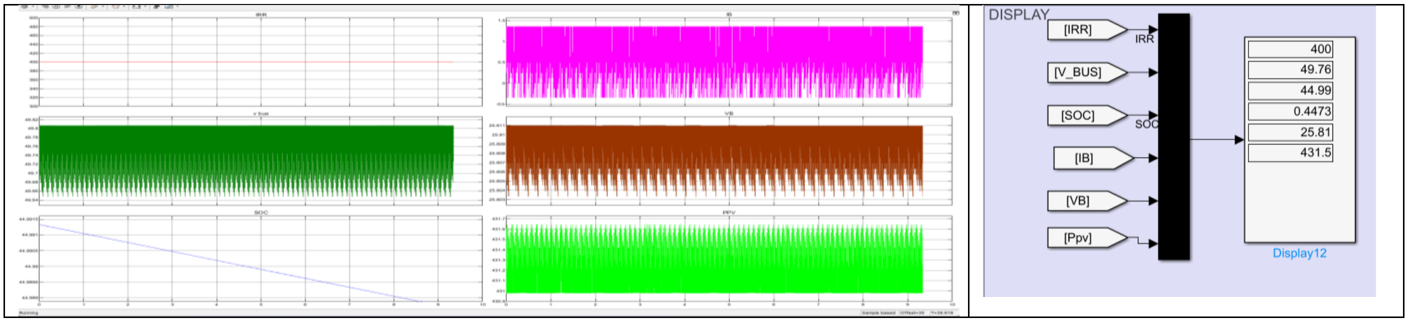
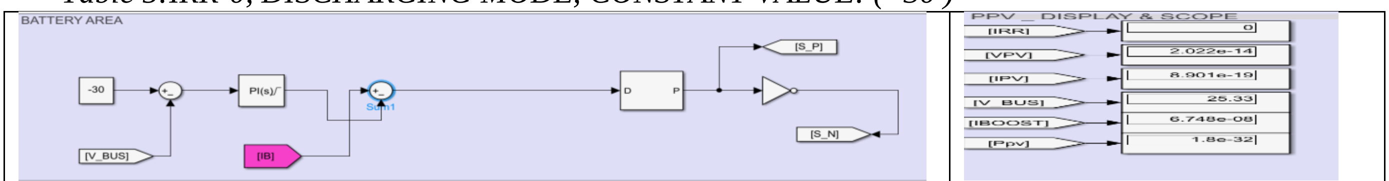


Table 5:IRR-0, DISCHARGING MODE, CONSTANT VALUE: (- 30)



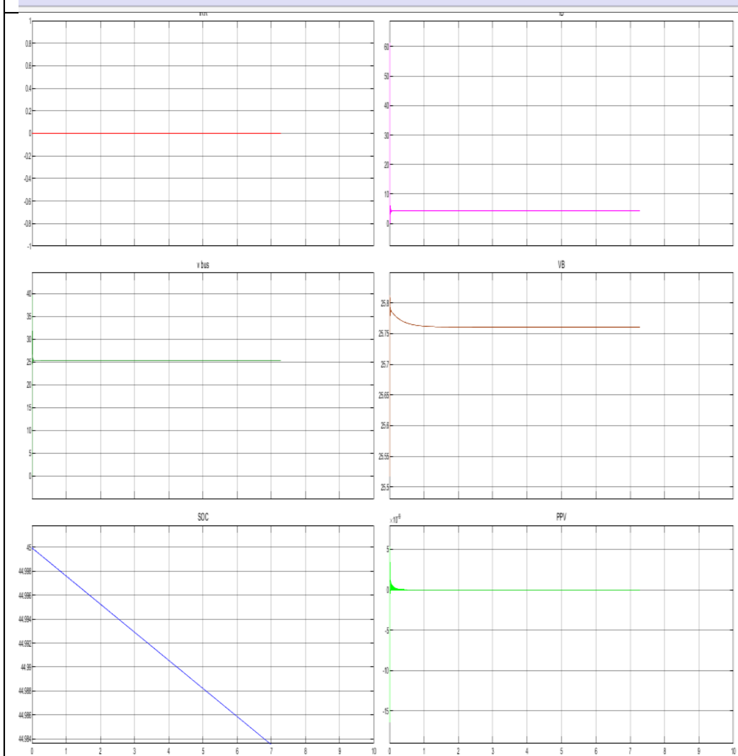


Figure 23: battery area scope

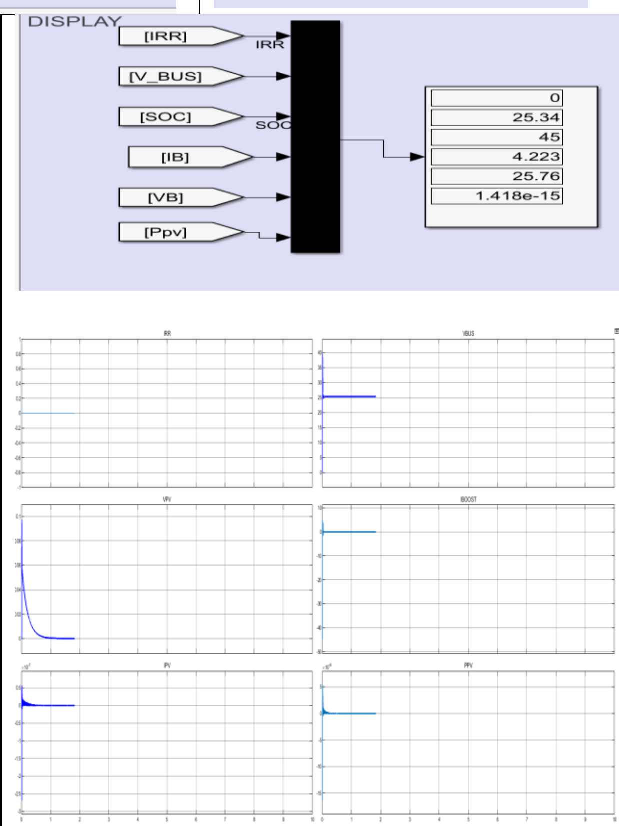


Figure 24; scope of the PPV- IRR-0

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5. CONCLUSION

The designed model works in good conditions and we can verify from both scope and from the display. The PV MPPT algorithm is producing the maximum power than the irradiance level and the system result is obtained as required.This designed project lowers costs and increases efficiency, but also improves the system's functionality. • To enhance the electrical energy storage capabilities of renewable energy systems. • To create a good working system using a PV array, a bidirectional converter, a battery bank, etc. •To continuously and cheaply produce electric power. • To identify the most effective method for regulating the duty cycle • To go along the system without using any external sources. Using this strategy, you can create an environment free of pollution with little power loss. Thus the designed system will be most efficient in the areas where the electricity is not reachable, and this system will be providing the main source as the power delivery to the required area according to the load demand. The system can be modeled and we can obtain the required output power.

6. REFERENCE

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