JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

SIMULATION OF A PV SYSTEM WITH BATTERY CONNECTED TO GRID USING MATLAB/SIMULINK

Ms. Shivastuthi L
Student
Dr. Ambedkar Institute of Technology
Affiliated to VTU
Bangalore, India

Ms. Karuna Prasad S
Student
Dr. Ambedkar Institute of Technology
Affiliated to VTU
Bangalore, India

Ms. Megha B S
Student
Dr. Ambedkar Institute of Technology
Affiliated to VTU
Bangalore, India

Dr. G V Jayaramaiah
HOD & Professor
Dept. Of Electrical & Electronics Engineering
Dr. Ambedkar Institute of Technology
Bangalore, India

Abstract- **This paper is about the simulation of a Photo voltaic system connected to Battery & Grid. In this paper we have dealt with storage system that is Battery & also the Grid connected system. We have studied the simulation results of this system using Simulink/MATLAB. The Buck-Boost converter is used to increase & decrease power based on the Battery requirement. This PV system consists of 36 cells in series & information about all other things will be given ahead in this paper.**

I. INTRODUCTION

Solar energy is a clean source, the greenhouse gases are not emitted into the atmosphere when solar panels are used to create electricity. The solar power becomes a very important energy source in the move to clean energy production. Once solar panels have been installed operational costs are low compared to other forms of power generations. Fuel is not required & this means that solar power can create large amounts of electricity without the availability & expense of securing a fuel supply.

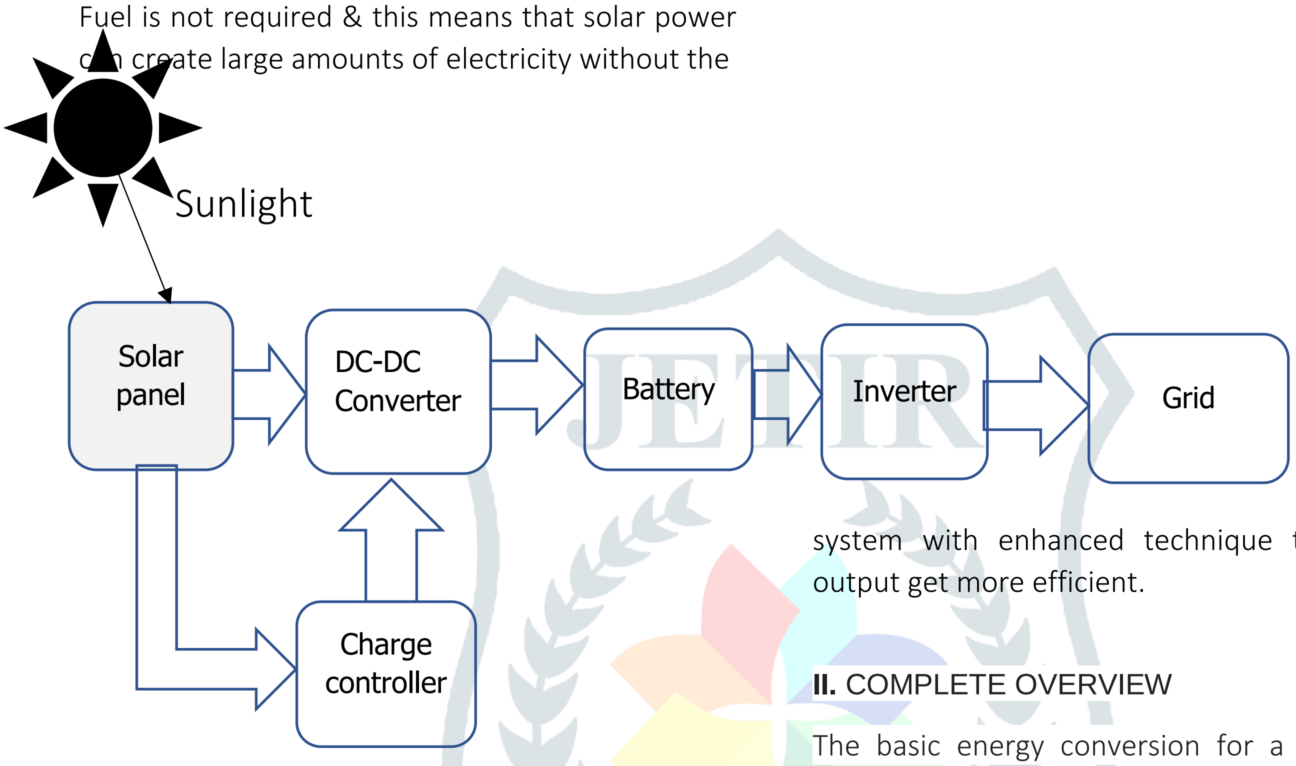


Fig. Schematic Arrangement of the complete system

Reading this paper, it will let the reader to discover the importance of solar panel for electricity generation. In India we get Coal imported from other countries because of power crisis due to higher electricity demand over six years almost as maximum power generation is by Coal that is thermal power plant. In this process, we can utilize the solar energy which is free to use & it's inexhaustible & no expense of it. Only the installation has the higher costs, even for that now a days government is providing subsidies & it also helps installers by Net metering supporting power production by solar panel & this is environmental friendly too, as a milestone towards clean energy production which may further lead to a better environment friendly electricity production.

We intend to give the information about the power generation using photo voltaic system with enhanced technique to make the output get more efficient.

II. COMPLETE OVERVIEW

The basic energy conversion for a complete PV system in work flow can be described as in below fig. The photons hitting the solar panel is absorbed, then this absorbed heat energy will be converted to electrical energy by photo conductive semi-conductor material inside the PV panel, after that this energy will be supplied through Buck-Boost converter to the load here Battery, then connected to Grid through Inverter, necessary programming for the PV module have been imposed in Simulink software.

III. MODELLING OF PV CELL AND MATHEMATICAL EQUATIONS

A simple equivalent circuit model for a PV cell consists of a real diode in parallel with an ideal current source. The ideal current source delivers current in proportion to the solar flux to which it is exposed. There are two conditions of interest for the actual PV and for its equivalent circuit, which are

1.the current that flows when the terminals are shorted together (the short-circuit current, I_{sc});
2.the voltage across the terminals when the leads are left open (the open-circuit voltage, V_{oc}).

When the leads of the equivalent circuit for the PV cell are shorted together, no current flows in the (real) diode since $V_d = 0$, so the whole current from the ideal source flows through the shorted leads. Since the short-circuit current must equal I_{sc}, the magnitude of the ideal current source itself must be equal to I_{sc}. When the leads from the PV cell are left open, the load current, I, is null and the V on the load is equal to $V_{oc} = V_d$.

Sometimes a more complex PV equivalent circuit is needed (e.g., in case of shading), for example, a PV equivalent circuit that includes some resistive elements accounting for power losses, such as: a parallel leakage (or shunt) resistance R_p and series resistance R_s (contact resistance associated with the bond between the cell and its wire leads, plus the resistance of the semiconductor itself).

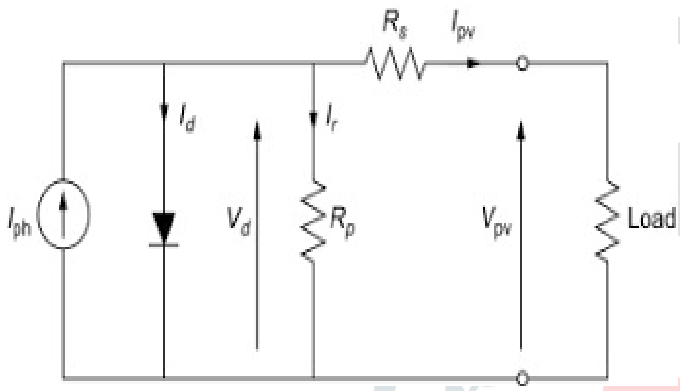


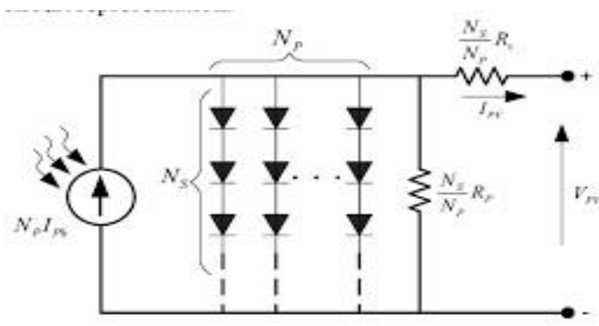
Figure.1 Equivalent circuit of PV cell

A current balance at a point to the left of Rps as shown in Fig. 2, and with the Shockley diode equation for the currents through the resistors and diode, yields the model characteristic equation:

$$I_{PV} = I_{ph} - I_d - I_p = I_{ph} - I_0\left(e^{\frac{V_{PV}+R_s I_{PV}}{n_s V_t Q_d}} - 1\right) - \frac{V_{PV}+R_s I}{R_p}$$

Where

- V_{PV} = PV module voltage (V)
- I_{PV} = PV module current (A)
- I_{ph} = light current (A)
- I_0 = diode reverse saturation current (A)
- Q_d = diode ideality factor
- n_s = number of cells in series
- R_s = series resistance (Ω)
- R_p = shunt resistance (Ω)



- $V_t = kT_c/q$ is the thermal voltage (V), k is Boltzmann's constant, T_c cell temperature, and q is the charge of an electron.

Figure.2 Equivalent circuit of pv Array

Solar panel is an assembly of photovoltaic cells which converts the light energy into electrical energy based on the principles of photovoltaic effect.

PV ARRAY SPECIFICATIONS

- Maximum Power=213.15W
- Cells per module(Ncell)=60
- Open circuit voltage(Voc)=36.3V
- Short circuit current(Isc)=7.84A
- Voltage at maximum power point(Vmp)=29V
- Current at maximum power point(Imp)=7.35A
- Temperature co-efficient of Voc=
- - 0.36099%/deg.C
- Temperature co-effecient of Isc=0.102%/deg.C
- Light Generated current =7.8654A
- Diode Saturation current(Io)=2.9273e^-10
- Diode Ideality factor=0.98119
- Shunt and Series resistances
- (Rsh & Rs) =313.0553 & 0.39381 ohms
- Description and values of different parameters mentioned above are given in the following table

Parameters	Description	Value	Parameter	Description	Value
Voc	Open circuit voltage	32.9 V	T	Ambient Temperature	301^0K
Isc,n	Short circuit current	8.21 A	Tn	Nominal temperature	300^0K
k	Boltzmann's constant	$1.38e^{-2}$	q	Electron Charge	$1.69e^{-19}$
N_s	Number of cells in series	54	n	Diode Ideality factor	2
N_p	Number of cells in parallel	1	I_0	Diode nominal saturation current	
G	Solar Insolation	800	$I0,n$	Diode nominal saturation current	$9.85e^{-8}$
G_n	Nominal Solar insolation	1000	Eg	Bandgap Energy	$1.12eV$
K_v	Voltage coefficient	-0.1230	I_g,n	Nominal current at STC	8.214
K_I	Current coefficient	0.0032	R_s & R_p	Series and parallel resistance respectively	$0.221\,\Omega\,,414.$

SELECTION AND DESIGN OF CONVERTER

DC – DC CONVERTER : It is used to convert unregulated DC into controlled DC output to avoid changes in DC output caused by atmospheric condition

TYPES of DC-DC converter

1. Buck converter
2. Boost converter
3. Buck boost converter

BUCK- BOOST CONVERTER

We use BUCK- BOOST converter because
It offer more efficient solution with fewer, smaller external components
They are able to both step-up or step-down voltages
They are comparatively less expensive than other converters

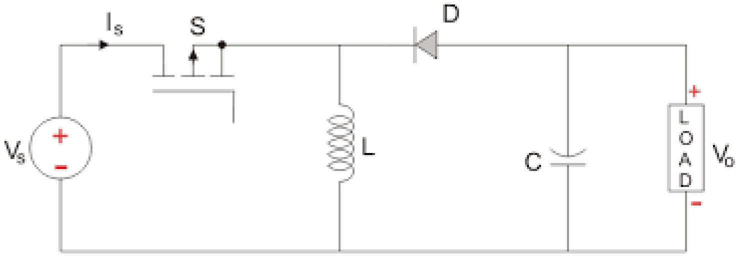


Figure.3 BUCK – BOOST converter circuit diagram

Buck Boost converter which can operate as a DC-DC Step-Down converter or a DC-DC Step-Up converter depending upon the duty cycle, D. The input voltage source is connected to a solid state device. The second switch used is a diode. The diode is connected, in reverse to the direction of power flow from source, to a capacitor and the load and the two are connected in parallel as shown in the figure above.The controlled switch is turned on and off by using Pulse Width Modulation(PWM). PWM can be time based or frequency based.

Frequency based modulation has disadvantages like a wide range of frequencies to achieve the desired control of the switch which in turn will give the desired output voltage.

Time based Modulation is mostly used for DC-DC converters. It is simple to construct and use.

The frequency remains constant in this type of PWM modulation. The **Buck Boost converter** has two modes of operation. The first mode is when the switch is on and conducting.

Mode I : Switch is ON, Diode is OFF

The Switch is ON and therefore represents a short circuit ideally offering zero resistance to the flow of current so when the switch is ON all the current will flow through the switch and the inductor and back to the DC input source.

The inductor stores charge during the time the switch is ON and when the solid state switch is OFF the polarity of the Inductor reverses so that current flows through the load and through the diode and back to the inductor. So the direction of current through the inductor remains the same.

Let us say the switch is on for a time T_{ON} and is off for a time T_{OFF}. We define the time period, T,

As and the switching frequency,

Let us now define another term, the duty cycle,Let us analyse the **Buck Boost converter** in steady state operation for this mode using KVL. Since the switch is closed for a time $T_{ON} = DT$ we can say that $\Delta t = DT$.

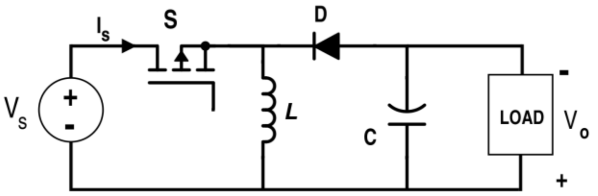


Figure.4 Negative- Output Buck-boost converter circuit diagram

Let the capacitor be totally charged up before switching on the switch S. When the switch S is closed as shown in Fig. 13,

$-VS + VL = 0$

$\Rightarrow VS=VL=L\, di/dt$

k-boost converter circuit when switch S is on (Mode-I)

Buck-boost converter circuit when switch S is on (Mode-I)

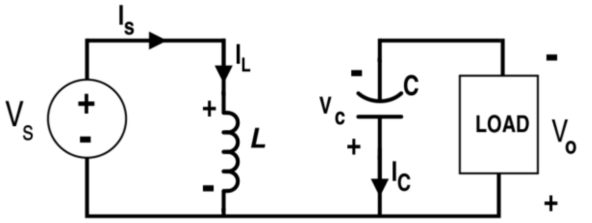


Figure.5 Buck-boost converter circuit when switch S is on (Mode-I)

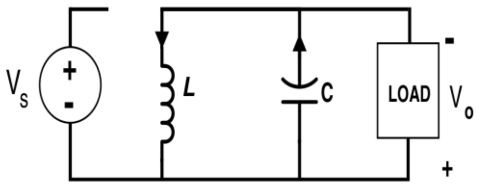


Figure.6 Boost converter circuit when switch S is off (Mode-II)

Now, when the switch S is opened as given in Fig. 14,

$+VL + VC = 0$

$Ldi/dt+VC=0$

$di/dt=-VC/L$

Note:

When $D < 0.5$, it acts as a step-down converter or a buck converter.

When $D > 0.5$, it acts as a step-up converter or a boost converter.

And when $D = 0.5$, input and output voltages are the same i.e.VO=VS.

That is why buck-boost converters are also called as DC transformers due to the same role in the case in AC.The converter discussed above is a negative-output buck-boost converter. But in some applications, reversal of polarity is not allowed. In such cases, we require a positive-output converter whose configuration diagram is given below:

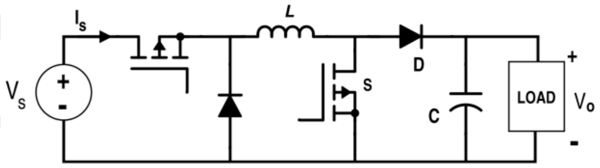


Figure.7 Positive-output buck-boost converter circuit diagram

Selection and design of battery

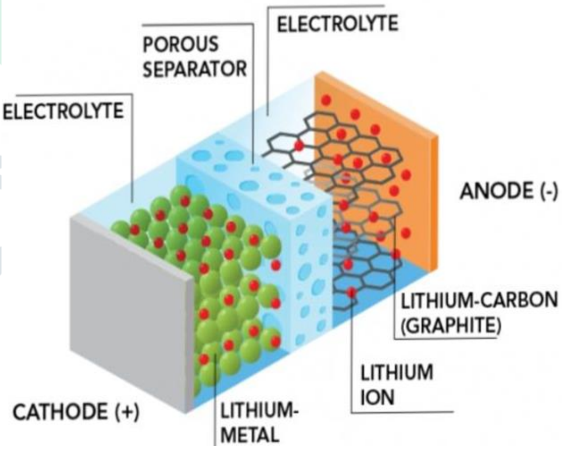
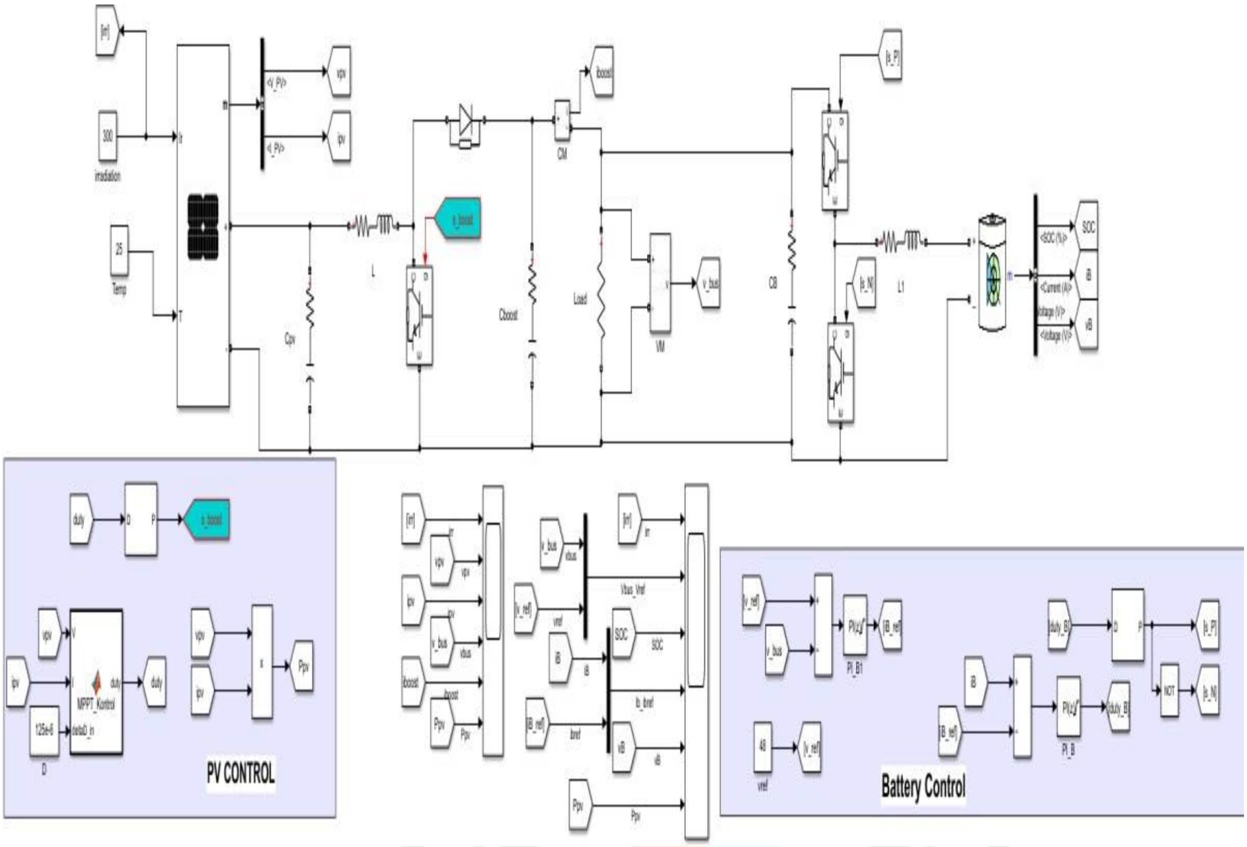


Figure shows Cylindrical Panasonic 18650 lithium-ion battery cell before closing.

Lithium-ion battery monitoring electronics (over-charge and deep-discharge protection) An18650 size lithium-ion battery, with an alkaline AA for scale. 18650 are used for example in notebooks or Tesla Model S

The three primary functional components of a lithium-ion battery are the positive and negative electrodes and electrolyte. Generally, the negative electrode of a conventional lithium-ion cell is made from carbon. The positive electrode is typically a metal oxide.



The electrolyte is a lithium salt in an organic solvent. The electrochemical roles of the electrodes reverse between anode and cathode, depending on the direction of current flow through the cell.The most common commercially used anode (negative electrode) is graphite, which in its fully lithiated state of LiC6 correlates to a maximal capacity of 372 mAh/g. The positive electrode is generally one of three materials: a layered oxide (such as lithium cobalt oxide), a polyanion (such as lithium iron phosphate) or a spinel (such as lithium manganese oxide). Recently, graphene-containing electrodes (based on 2D and 3D structures of graphene) have also been used as components of electrodes for lithium batteries.

The electrolyte is typically a mixture of organic carbonates such as ethylene carbonate or diethyl carbonate containing complexes of lithium ions. These non-aqueous electrolytes generally use non-coordinating anion salts such as lithium hexafluorophosphate (LiPF6), lithium hexafluoroarsenate monohydrate (LiAsF6), lithium perchlorate (LiClO4), lithium tetrafluoroborate (LiBF4), and lithium triflate(LiCF3SO3).

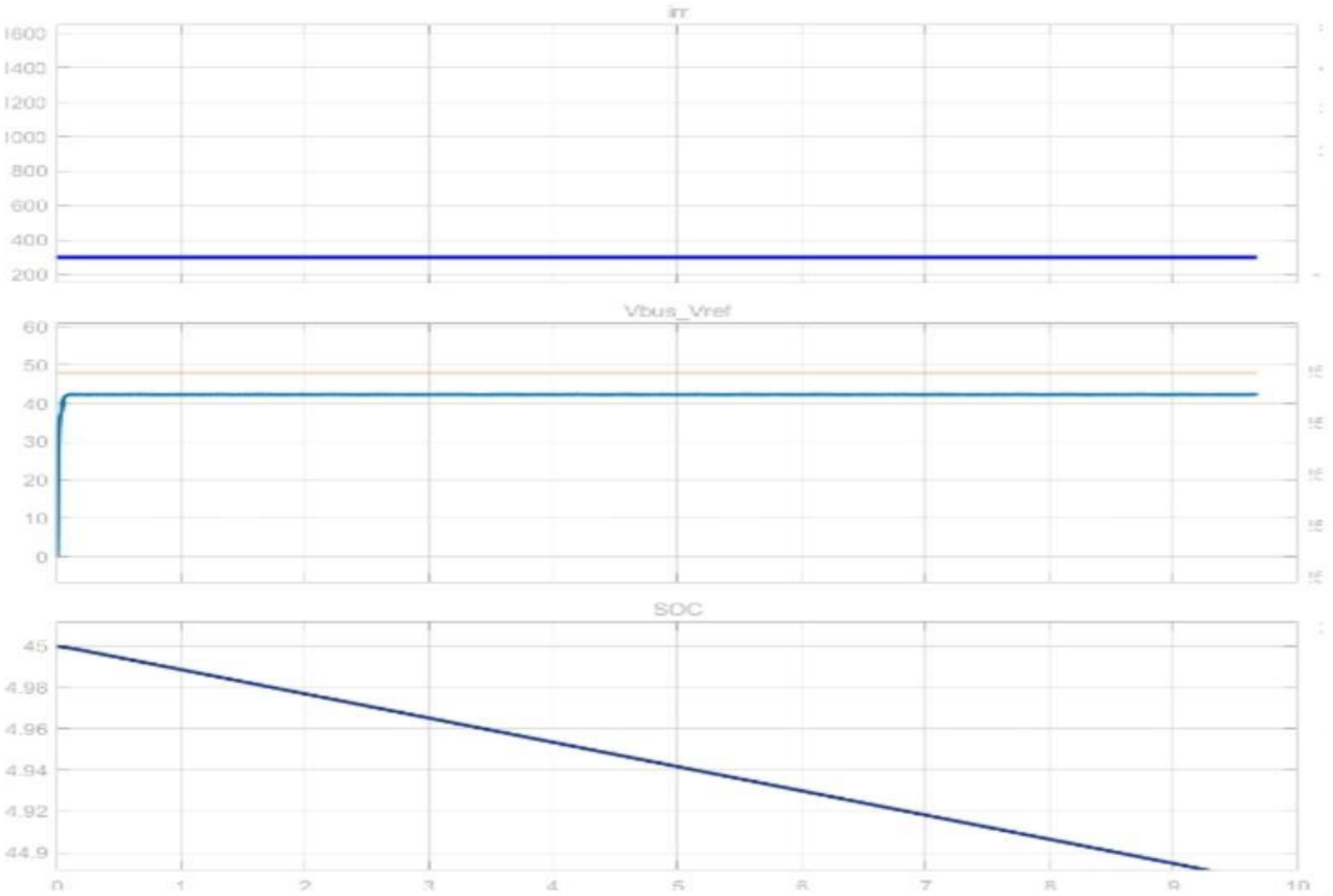
Depending on materials choices, the voltage, energy density, life, and safety of a lithium- ion battery can change dramatically. Current effort has been exploring the use of novel architectures using nanotechnology have been employed to improve performance. Areas of interest include nano-scale electrode materials and alternative electrode structures.

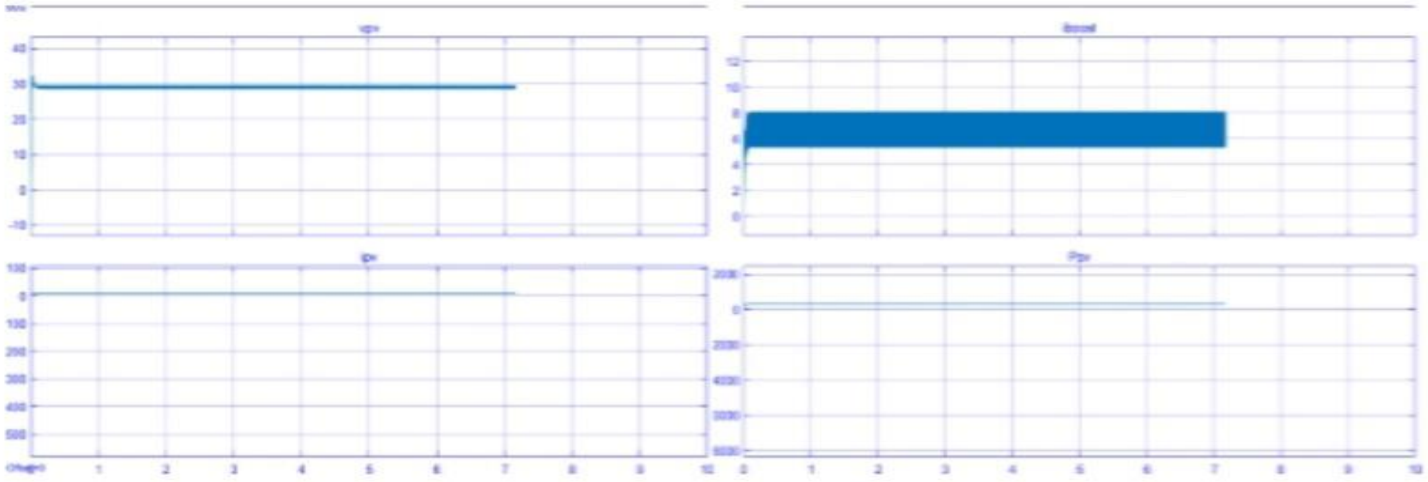
Pure lithium is highly reactive. It reacts vigorously with water to form lithium hydroxide (LiOH) and hydrogen gas. Thus, a non-aqueous electrolyte is typically used, and a sealed container rigidly excludes moisture from the battery pack.

Lithium-ion batteries are more expensive than NiCd batteries but operate over a wider temperature range with higher energy densities. They require a protective circuit to limit the peak voltage.

The battery pack of a laptop computer, for each lithium-ion cell, will contain a temperature sensor a voltage regulator circuit a voltage tap a charge-state

Simulation





Output Graph for the above Simulation

CONCLUSION

A step-by-step method for simulating PV array is presented. This method provides an easy, reliable and very flexible method to tune PV array with Battery systems along with time varying environmental conditions (i.e. irradiation, temperature) and/or varying physical parameters (solar module resistance, ideality factors etc.). The characteristics curves are developed using simulated modules, and the obtained results are well matched with the datasheet information. The model has very good accuracy in obtaining P-V and I-V curves. Each of these sources allows avoiding occurrence of emergencies and infringement of the technological process continuity. The main stages of choosing structure, main parameters and content of proposed guaranteed charging system are presented.

FUTURE SCOPE

- Various future applications can be used by providing continuous uninterrupted power supply and productivity can be improved.
- This project can be further enhanced by adding some more features so that, best possible power supply can be used and the cost of electricity bill can also be reduced.
- This project increases the use of renewable sources of energy such as solar energy, wind energy etc. Use of renewable energy sources doesn't pollute the environment as they are eco-friendly in nature. By this, non renewable energy sources such as coal, oil and natural gas can be conserved.
- The tracking curves represents dynamic response of MPP searching capability of the model. For further extension and future work like partial shading effect analysis, Solar pumping system, Grid connected PV system, high voltage PV application and smart grid photovoltaic interconnection system can make use of this model as fundamental stage.
- Improvement of this project can be made by charging lithium-ion battery with all four-charging step that are: trickle charging, constant current charging, constant voltage charging and float charging. For future work the complete charging process should be analysed to compare with another system working without (INC) MPPT algorithm [8]. From the preliminary results it is expect that the charging process using the MPPT algorithm will be faster.

REFERENCES

[1]. G.C Hsieh, C.Y. Tsai, and H.I. Hsieh, “Photovoltaic Power-Increment Aided Incremental-Conductance Maximum Power Point Tracking Controls,” in Proc. IEEE PEDG, pp. 542-549, Aalborg, Denmark, 2012.

[2]. G.C. Hsieh, S.W. Chen, and C .Y. Tsai, “Interleaved Smart Burp PV Charger for Lead Acid Batteries with Incremental Conductance MPPT,” in Proc. IEEE ECCE, Phoenix, pp. 3248-3255, 2011.

[3]. Azadeh Safari and Saad Mekhilef, “Simulation and Hardware Implementation of Incremental Conductance MPPT With Direct Control Method Using Cuk Converter”, IEEE Trans. Ind. Electron, vol. 58, no. 4, pp. 1154 – 1161, April 2011.

[4]. M. Gradella, J. Rafael, E. Ruppert,” Comprehensive approach to Modeling and simulation of photovoltaic arrays”, IEEE Trans. Power Electron. vol. 24, no. 5, May 2009.

[5]. B. Liu, S. Duan, F. Liu, and P. Xu, “Analysis and improvement of maximum power point tracking algorithm based on incremental conductance method for photovoltaic array,” inProc. IEEE PEDS, 2007, pp. 637–641.

[6]. Z. Yan, L. Fei, Y. Jinjun, and D. Shanxu, “Study on realizing MPPT by improved incremental conductance method with variable step-size,” inProc. IEEE ICIEA, Jun. 2008, pp. 547–550.

[7]. W. Xiao,M. G. J. Lind,W. G. Dunford, and A. Capel, “Real-time identification of optimal operating points in photovoltaic power systems,” IEEE Trans. Ind. Electron., vol. 53, no. 4, pp. 1017–1026, Jun. 2006.

[8]. S. Minami, Y. Onishi, S. J. Hou, and A. Kozawa, “A New Intense Pulse charging Method for the Prolongation of Life in Lead-acid Batteries” Journal Asian Electric Vehicles, Vol. 2, No. 1, pp. 541-544, 2004.

[9]. D.P Hohm, M. E. Ropp, “Comparative Study of Maximum Power Point Tracking Algorithms Using an Experimental, Programmable, Maximum Power Point Tracking Test Bed”, Photovoltaic Specialists Conference, 2000. Conference Record of the Twenty-Eighth IEEE,pp 1699 – 1702, 15-22 Sept. 2000.