ISSN (Online) 2395-2717

International Journal of Engineering Research in Electrical and Electronic Engineering (IJEREEE)
Vol 2, Issue 11, November 2016

Perturb and Observe Algorithm for the Design and Simulation of Solar Photovoltaic System

[1] Nandaraja H Shadlageri [2] Anasuya Patil[3]S.S.Nidhi[4]SuhailGouse[5] Dr. Pradeep B Jyoti
[1] Assistant Professor [2] Associate Professor [3][4] Student [5] Professor
[1][2][3][4][5] Department of EEE, RYM Engineering College, Ballari

Abstract: **-- The limited resources and high cost of conventional energy sources like oil, gas, coal, as well as the continued environmental pollution are some of the main reasons for wide spread introducing of renewable energy sources in electrical power systems. The development and usage of these alternative energy technologies are still restricted. Solar energy has the greatest potential of all the sources of renewable energy. This work deals with the design and simulation of a simple but an efficient solar photovoltaic PMDC water pumping system. The system employs the Maximum Power Point Tracker (MPPT). The MATLAB simulations perform comparative tests of two popular MPPT algorithms, called Perturb and Observe algorithm and Incremental Conductance method using actual solar irradiation data and temperature coefficient data. Under the natural atmospheric condition is considered for data. And then PV model parameters are calculated, analyzed and compared with the simulated values. The design offers lower system cost due to use of fewer sensors on the output sensing, direct control technique. The MATLAB simulations verify the system and functionality of MPPT. Simulations also make comparison with the system without MPPT .This method is best suited for developing countries like India to fulfil their electric power network in rural areas.**

Keywords — MPPT, Irradiation, PV system. P&O.

I. INTRODUCTION

The energy is one of the fundamental source, it is needed for the development of any country in economical view. Energy security is very essential for the stronger development of economy [1]. The increased use of fossil fuels and concern about the environmenthas been lead to work on the alternative form of energy resources. Such renewable energy resources are hydro, geothermal wind, biomass solar, tidal etc. These are the energy sources which are not putting their impact on environment, because these are free from pollution and moreover not injecting Green House Gases to the atmosphere. Among these resources, solar energy is widely using over the world and according to an estimation it has potential of 1,78,00,00,00,000 Megawatt[2] and which is nearly twenty thousand times the demand of world. It is not developed in such a large scale so far, because it requires large space and unavailable and uncertain resources due to natural disasters due to winds, haze, clouds, humidity.

For the developing countries like India, energy is very necessary for its sustained growth in all respects. The India is mainly depends on the Non renewable energy sources such as nuclear power, diesel power system, fossil fuels. These are getting down day by day. And hence these are not promising for future growth of any country and hence renewable energy sources are started use over the world[3]. These sources are finding good importance due to less expense. But it has high initial cost and capital cost. Apart from these few drawbacks, it haslong durability and minimized cost of maintenance.

The Photovoltaic(PV) energy is converted into electrical energy and then it is used for the purpose applications such as solar water Heaters, standalone PV systems, solar furnaces, for refrigerator applications and many more. For an electrical pump, PV produced electrical power is supplied to run the PMDC water pump system. The Water Pumping system contains, Solar arrays, DC-DC Converter, storage device and load system [6]. The energy utilization is very import in the developing countries like India. It lies in a region where sun light is very abundant for all the time of the year because it has clear temperature and good climate zones [4]. These sources finding good importance due to less expense but initial cost and capital cost is high. Apart from this drawback these are long durable and minimized maintenance cost [7].

II. PHOTOVOLTAIC MODULE

A. Photovoltaic Cell

The equivalent circuit for the PV module is given in the following fig.1 and it consists of ideal diode,

ISSN (Online) 2395-2717

International Journal of Engineering Research in Electrical and Electronic Engineering (IJEREEE)
Vol 2, Issue 11, November 2016

resistance Rs in series and resistance Rp in parallel. Iph is the Photon generated current and IL is the output current under constant temperature and irradiance [5]

The output of solar PV cell is dependent on the cell voltage and current. It produces the power for both series and parallel combination. Irradiance is proportional to the cell current.

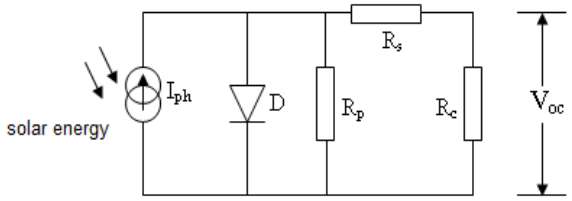

Fig.1 Equivalent circuit of PV module[8]

$$I = I_{sc} - I_d \quad (1)$$

Where,
I_{sc},short circuit current, equal to photon generated current.
I_d – Shunt current through an intrinsic diode.
The diode current I_d is given by the Shockley's diode equation:

$$I_d = I_o(e^{qVd/kT} - 1) \quad (2)$$

$I_o$denotes the reverse saturation current of diode (*A*), *q* -electron charge ($1.602\times10^{-19}C$), V_d is voltage across the diode, *k* is Boltzmann's constant ($1.381\times10^{-23}J/K$) and *T*is the junction temperature in *Kelvin (K)*.

$$I_d = I_{sc} - I_o(e^{qV_d/kT} - 1) \quad (3)$$

B. Modelling Of PV Module

PV module Power 450 W PV module is designed and chosen for the MATLAB simulation model. Designed values are tabulated in Table.1.

Table:1Proposed Data sheet for PV module Power 450 W

Electrical Quantities	**Notation**	**Range**
Maximum Power	P_{max}	450 Watts
Input voltage at P_{max}	V_S	55 Volts
Input current at P_{max}	I_{mp}	8.28 Ampere
Temperature coefficient P_{max}	T_{Pmax}	-0.45%/K
Open Circuit Voltage	VOC	60 Volts
Short Circuit Current	ISC	8.05 ampere
Temperature coefficient Voc	T_{VOC}	- 0.30 % / K
Temperature coefficient Isc	T_{ISC}	0.004% /K

III MAXIMUM POWER POINT TRACKER

A. Perturb and Observe Algorithm

This is one of the best algorithms, used to track maximum power point during all seasons such as cloudy or sunny days. The following flow chart gives the entire methodology of MPPT using this algorithm [6].

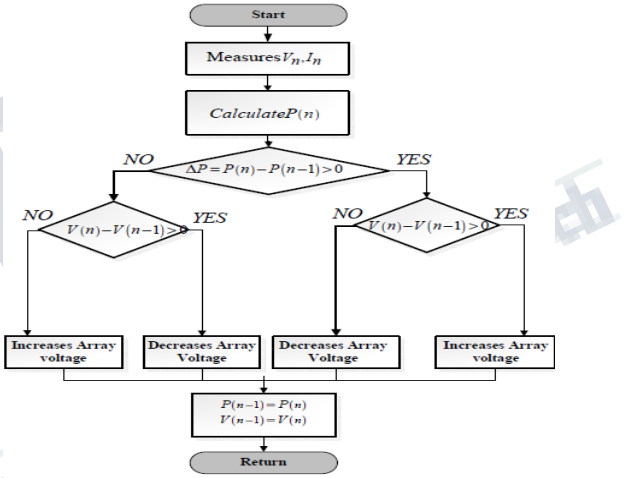

Fig.2. Flow Chart Of Perturb And Observe Algorithm

B.Hybrid Boost Mode Cuk Converter

The CUK converter is a buck boost type conveter but it is not giving steep output voltage to avoid this problem the hybrid boost cuk converter is proposed in this work. The circuit diagram of the cuk and hybrid boost cuk converter are shown in fig.3(a) and 3(b) respectively.

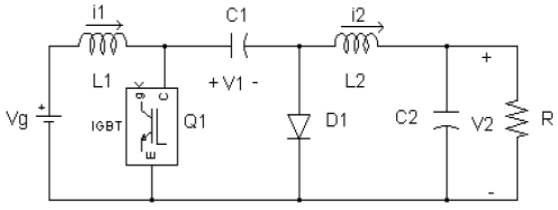

Fig.3(A) Circuit Diagram For The Cuk Converter

ISSN (Online) 2395-2717

International Journal of Engineering Research in Electrical and Electronic Engineering (IJEREEE)
Vol 2, Issue 11, November 2016

Before Design of A Converter for a Stand Alone System, a Issue of Storage And Efficient Converter Is Arised To Avoid Such Problems The Hybrid Boost Mode Cuk Converter Is Designed Here For Varying Irradiance And Duty Cycle.

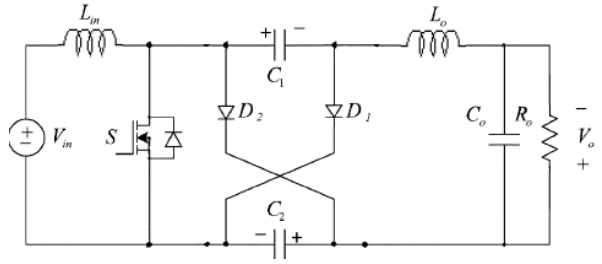

Fig.3(B) Diagram Of Hybrid Boost Cuk Converter[4]

The Output Voltage Is Compensated By Using The Following Equations.

$$V_I D + (V_I - V_C)(1 - D) = 0 \quad (4)$$

$$V_o = \frac{V_i (1+D)}{(1-D)} \quad (5)$$

IV RESULT AND DISCUSSION

A Comparison Of P&O And Incando Algorithm

The Perturb and Observe and Incremental Conductance method has been discussed in earlier chapters. Those methods have been simulated under MATLAB. Following Fig.4 gives the relation between output voltage and output power under different temperature values of the module and for changing irradiation data during sunny days.

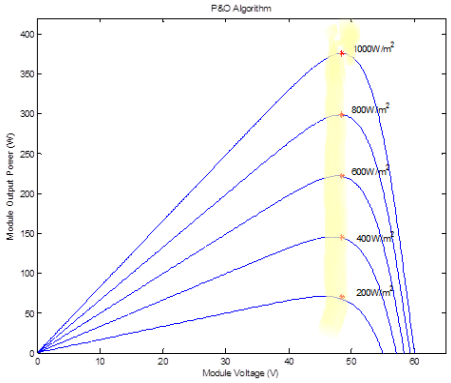

Fig.4 P-V relationship during cloudy days for perturb algorithm

Fig.5 gives variation in output power and output voltage during the cloudy days at constant temperature of 25 degree Celsius.

Fig.6 gives the relation between output power and voltage at 550watt/m^2 and 1000 watt/m^2.

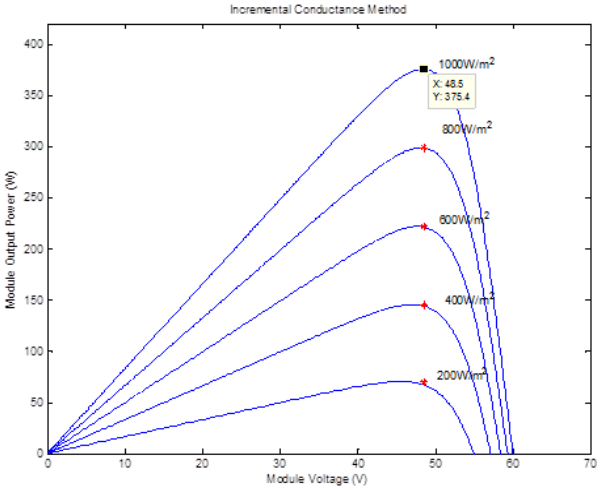

Fig.5 P-V relationship of PV module during sunny days.

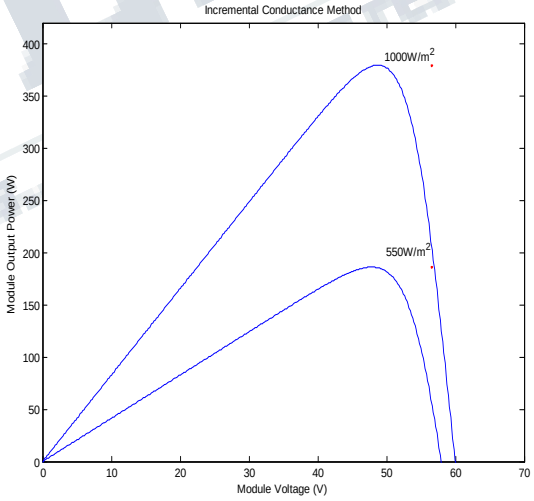

Fig.6. output P - V relationship for 550watt/m^2 and 1000 watt/m^2

These Simulations areperformed for the two familiar MPPT techniques by using actual solar irradiations under varying conditions of atmosphere. The Incremental Conductance method gives better performance than P&O method in the view of efficiency for cloudy atmosphere. The smaller systems required

ISSN (Online) 2395-2717

International Journal of Engineering Research in Electrical and Electronic Engineering (IJEREEE)
Vol 2, Issue 11, November 2016

four sensors for the developing of a simple and effective cost system. The work adopted with direct output control sensing method and employed by Hill climbing method and it needs only two sensors.

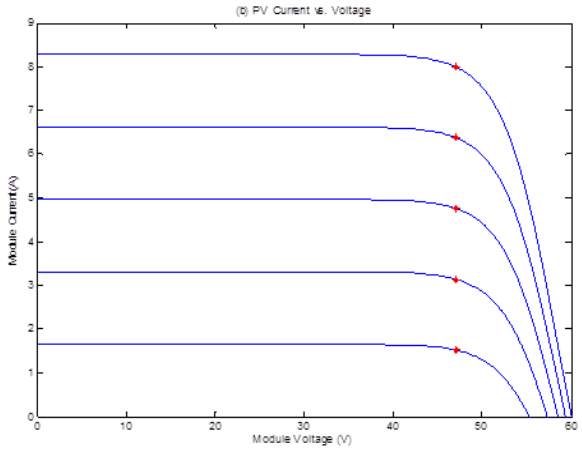

Fig.7 Output voltage and Current relationship for 450watt PV module under 25 degree Celsius

As the temperature increases the peak power point is goes on decreases simultaneously resulting in decrease in voltage and current for the PV system. The control method offered the benefit of steady-state analysis for the DC-DC converter. It is performed by sampling the voltage and current, at continuous Steady-state. From the Simulation results made the comparisons between the system with and without MPPT in terms of total energy produced. The MATLAB and SIMULINK results validated, the MPPT can significantly increases with the increasing efficiency of energy production by Photovoltaic System. The results also compared performance of the PV water pumping system without MPPT also single diode model in medium complexity which provides good matching with the PV system.

V CONCLUSION

This work presented a simple and an efficient Standalone Solar Photovoltaic Water Pumping System. The modelled every components are Simulated and validated in MATLAB. The results showed that the Photovoltaic model using the single diode model in medium complexity, which provides a good matching with the PV system. Simulations are performed for the two MPPT techniques by using actual solar irradiation under varying conditions of atmosphere. The Incremental Conductance method gives better performance than P&O method in the view of efficiency for cloudy atmosphere. The smaller systems required four sensors for the developing of a simple and effective cost system. The work adopted with direct output control sensing method and employed by Hill climbing method and it needs only two sensors.

REFERENCES

1) WeixiangShen, Yi Ding, FookHoongChoo, Peng Wang, Poh Chiang Loh and KuanKhoon *"Mathematical model of a solar module for energy yield simulation in photovoltaic systems"*.

2) N.Chandrashekaran,K.Tyagaraja.*"ModelingAnlyysis and Simulation of Pumping System Fed by PV Generator"*. European Journal of Scientific Research ISSN-1450 Vol.53,No.-52 Published in 2011

3) Wael A Y Salah, and S Taib, *"Improvement of Transformer less 200W SMPS Using CUK DC-DC Converter"* Member, IEEE. First International Power and Energy Conference PECon 2006 497 November 28-29, 2006, Putrajaya, Malaysia

4) R. Sankarganesh and S. Thangavel*"Maximum Power Point Tracking in PV System using Intelligence based P&O Technique and Hybrid Cuk Converter"* International Conference on Emerging Trends in Science, Engineering and Technology, IEEE-2012

5) C. Liu, B. Wu and R. Cheung *"Advanced Algorithm for control of Photovoltaic systems"*.

6) *Introduction to Photovoltaic Systems Maximum Power Point Tracking*. By Texas Instrumentation SLVA446–November 2010.

7) M.I.ArteagaOrozco, J.R.Vázquez, P.Salmerón, S.P.Litrán, F.J.Alcántara **"***Maximum power point tracker of a photovoltaic system using sliding mode control"*. International Conference on Renewable Energy and Power Quality Valencia 2009

8) A.A.S. Mohamed, Alberto Berzoy and Osma Mohammed *"Optimized fuzzy MPPT Controller Using GA for Stand-alone Photovoltaic Water Pumping System"*.IEEE-2014