A Novel PV/T solar Collector System with Hybrid Energy Storage Units and Solar Heaters

S Palani Kumar, K Ramesh Babu, Sd Huzaifa Ahamed

Abstract: ***A hybrid photovoltaic-thermal (PV&T) solar air heater is a system which generates both heat energy as well as electricity instantaneously. Presented paper is to controlling of interconnected photovoltaic system, super capacitor, battery. The investigated photovoltaic system consists of PV arrays, super capacitor, battery, DC-AC, DC-DC, and Z source inverter and power, to make continuous supply to grid. In instruction to create this process of work as a traditional generator to join in grid regulation. The DC bus voltage is get controlled uniformly by battery and ultra-capacitor . If continuous active-reactive power management is enforced within the controller of the DC-AC converter that the DC bus of photovoltaic PV system and also the main network. The Air as heat eliminating fluid and the normal air flow through an upper channel and hot air coming from lower channel of the collector.***

Index Terms: Z-Source inverter; photovoltaic (PV); battery; super-capacitor.

I. INTRODUCTION

Grid connected electrical phenomenon of photovoltaic (PV) production has been establishedradically in currentcenturies and bit by bit procedures a significant part of the main grid. However, the irregular nature of photovoltaic (PV) power makes it give very little to the steadiness and financialtaskof the grid and even brings harmful effect to the grids power excellence. The well workedPV-storage system may be thehelpful to the main grid power by delivering active and reactive power required to the grid.

Operation of energy storage units in power systems networkcan be distributed into the 2 types. First is response to quick transients and therefore the alternative is said to steady state energy swapping. Ultra-capacitors are smart applicants for the previous submission and enormous capability batteries are appropriate for the previous one. Presently the mixed use of quick and slow energy storage units is acquiring quality for the interconnection of the renewable production.

This project is planned to efficient control technique to createinterrelated photovoltaic systems (PV) systems is more grid-responsive. Examined photovoltaic scheme consists of PV arrays, super capacitor, battery, DC-AC, DC-DC, and Z source inverter and power converters. The DC bus voltage is uniformly organized by the battery and ultra-capacitor. The (MPPT) managementscheme is useful to grab maximum power from the PV arrays .

The popularusageof solar power systems be governed by on their efficiency or show as well as upon alternative issues like strength, price also dependability and safety characteristics. Many analysis and increaseplatforms have applications of solar power systems. A hybrid photovoltaic-thermal (PV-T) solar air warmer is a scheme which causes the both heat energy and electricity instantaneously .

II. PHOTOVOLTAIC SYSTEM

A Photovoltaic cell is a semiconductor device which produces electricity when it is exposed to sunlight depending on intensity of a irradiance and the temperature. Solar cells are made up of silicon and each cell can generate a maximum open circuit voltage of cell is 0.5 to 0.6 volts. Solar panels are being commercialized in many countries due to its less maintenance, pollution free and many long-term benefits. The biggest challenge in using the PV power generation is tackling the non-linear characteristics of solar array. The characteristics will depend on the level of irradiance and temperature. As the solar panel experiences different irradiance levels due to the passing clouds, trees, neighboring buildings etc. The equivalent circuit diagram of solar cell

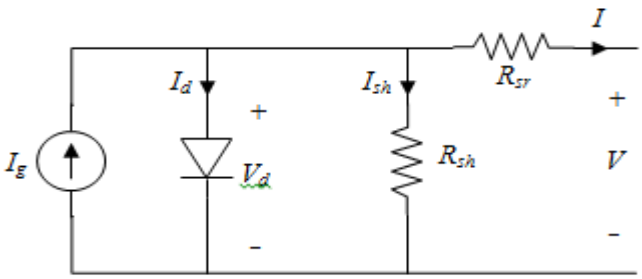


Fig. 1. Equivalent circuit of solar cell

The elementary mathematical equation that defines a solar cell as

$$I_{LD} = I_g - I_{sh} - I_d \quad \text{----------equation (1)}$$

III. PV SYSTEM AND CONTROL SCHEME

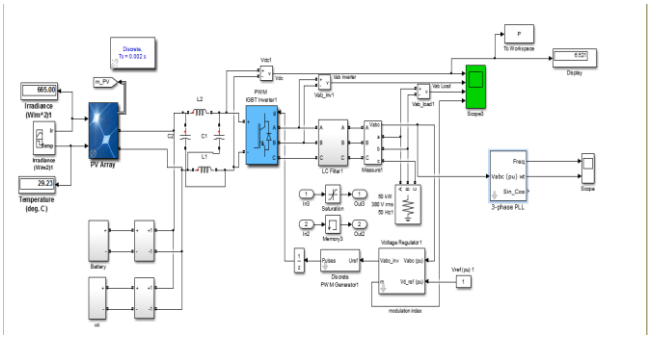
The investigated photovoltaic scheme consists of photovoltaic (PV) arrays, super capacitor, battery, DC-AC, DC-DC, and Z source inverter and power converters.

Revised Manuscript Received on May 06, 2019.

S Palani Kumar, Department of EEE, Koneru Lakshmaiah Education Foundation, Vaddeswaram, A.P, India.
K Ramesh Babu, Department of EEE, Koneru Lakshmaiah Education Foundation, Vaddeswaram, A.P, India.
Sd Huzaifa Ahamed, Department of EEE, Koneru Lakshmaiah Education Foundation, Vaddeswaram, A.P, India.

The photovoltaic (PV) array is connected to the DC bus from end to end a DC-DC BOOST converter. The hybrid energy storage units (HESU) consistof lead acid-batteries and capacitors. The hybrid energy storage units (HESU) batteries and ultra-capacitorlinked to the DC bus through a two bidirectional (buck-boost) DC-DC converters.(U_{dc})-is a DC bus power and it kept constant.

DIAGRAM

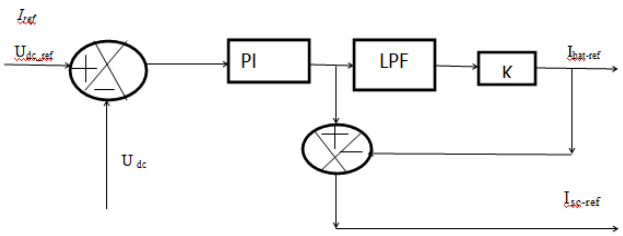


Thisgovernor scheme of the overhead photovoltaic (PV) arrangement is planned to create a method responsive togrid. This planned controllerscheme of the photovoltaic (PV) array the (MPPT) is controlled by the DC-DC improvement converter. The DC transport voltage is kept up as steady by the batteries and the super capacitor through (DC-DC) buck-boost converter. The inverter regulator is planned as the power manager it requires the power positions inputted from energymanaging system of the power grid. This system operator makes the inverter generation setup supported to the situations of the PV array and therefore load needs.

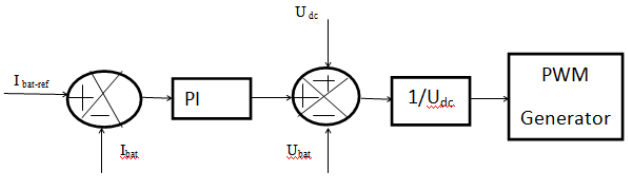
IV. HYBRID ENERGY STORAGE UNITS CONTROL STRATEGY

Ultracapacitors havehigh power density and quick response on other hand battery has a high energy density slow charging and discharging speed is high. Ifvaried use of those energy storing units will build them free of charge to each other. Supported the top of features of the super capacitor and battery hybrid energy storage controller theme is projected.

DIAGRAM

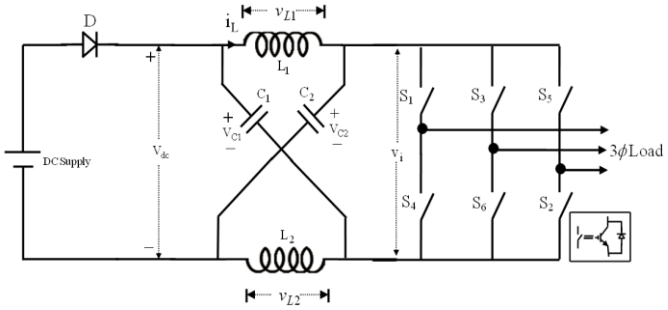


In this control strategy the DC bus power is coordinately measured by super capacitor and the battery. First, we have to measured DC bus voltage (Udc) is related with the reference DC bus voltage Udc-ref and thereforedistinction is shipped to the proportional integration (PI) controller to get current positions Iref. Then(Iref)is divided into two types. 1) Battery current reference (Ibat-ref) it is acquired byput on a low pass filters (LPF) and a coefficient K to Iref and another one is Isc-ref it is the difference between Iref and I battery-ref it means that high frequency part of the DC bus troubleis cleared and smooth out by the battery.



V. Z-SOURCE INVERTER

Z-source inverter is a single impedance network and it is connected between the DC power supply and inverter bridge and it provides the both voltage buck and boost properties. The another feature of the Z-source inverter is the output AC voltage could be any value between zero and infinity regardless of DC supply voltage. The Z-source inverter has both buck-boost properties and it has a wide range of terminal voltage control for the AC load. It consists of input of DC voltage source and impedance source network like (consists of two equally diagonally connected capacitors and two series inductors) and output of Z-source connected to the AC load. This lattice networks are used for filter sections and also used as attenuators. The inductors L1 and L2 are connected in series and C1 and C2 are diagonal capacitance and the Z-source network is 2-port network .



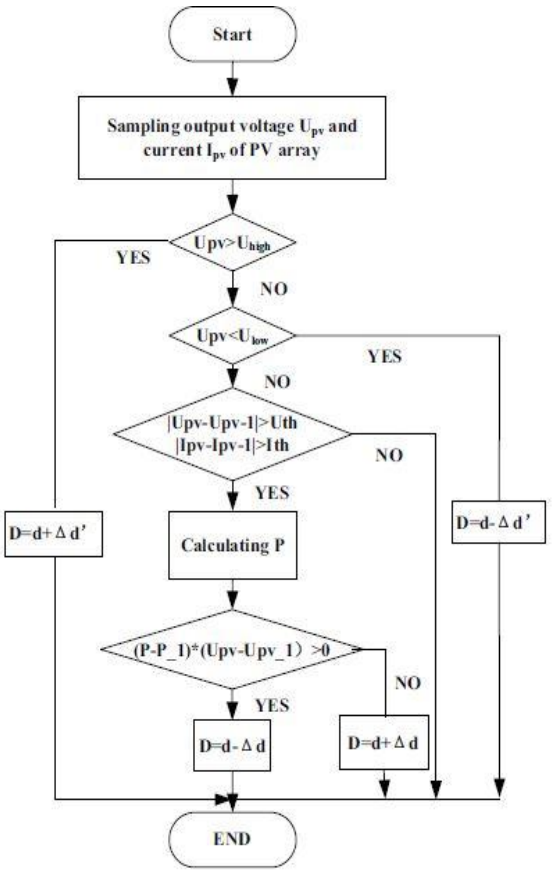
VI. MPPT CONTROL PHOTOVOLTAIC (PV) ARRAY

Each type of PV panel has its own characteristics depending on the surrounding conditions, as we know that the two factors that will affect the output power is irradiance and temperature, as these two factors vary continuously for every instant of time. So, it makes the maximum power point tracking complicated. To overcome this problem and to get the maximum power from the solar or PV panel, we are having many control techniques to achieve maximum power point (MPP). Few of the control techniques that are commonly used are incremental conductance (INC), perturb and observation method (P&O) or hill climbing method, constant voltage control, constant current control, artificial intelligent techniques (fuzzy logic control and neural networks) etc. Most of the existing algorithms suffer from the slow tracking.

The output obtained from the PV system will consists of harmonics due to closed loop tracking of solar and this can be reduced by using filter circuit and the output obtained from the PV system is given to the DC-DC converter and the inverter.The most commonly used technique is perturbed and observation method (P&O) as it is known for its simple structure and ease of implementation. Generally from the conventional P&O algorithm it is identified that it compares or it takes the difference between the previous step power with next step power if the power difference is positive then the perturbation moves forward, if the value of power reaches the maximum point and decreases then the next perturbation reverses, when the power reaches steady-state the perturbation will oscillates around the MPP [1]. But the main disadvantage in P&O is fixing the step size P&O mainly uses fixed step size. if the step size is large enough then the accuracy will decrease, If the step size is too small then the faster dynamic response will not be able achieve during rapid change in weather conditions. Incremental conductance method can be determined if the MPPT has reached the MPP the perturbation stops. The slope of the PV module power is zero at MPP and increasing (positive) on the left side of MPP and decreasing (negative) on right side of MPP i.e.,

dP / dV = 0 at the MPP
dP / dV > 0 left of MPP
dP / dV < 0 right of MPP

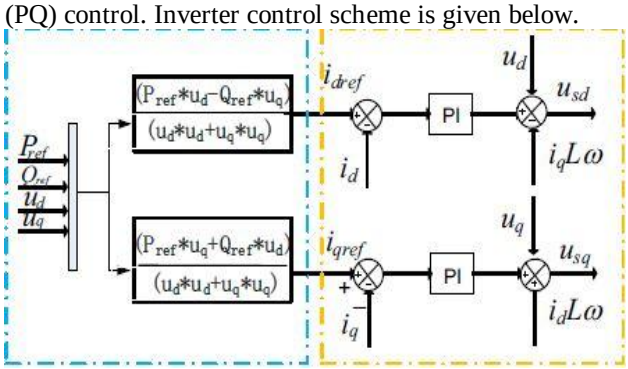
This method is based on whether the array voltage is greater than or less than peak power point voltage.



MPPT flow chart (P&O)

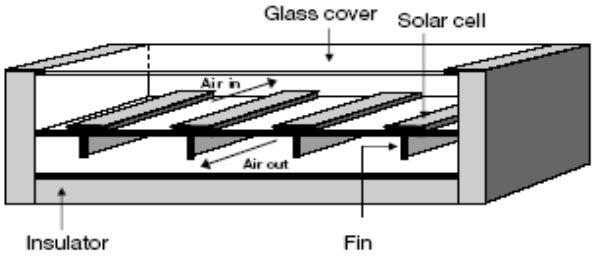
3-phase inverter control strategy

The network-connected (DC-AC) inverter produces the both active and reactive power with the help of constant power (PQ) control. Inverter control scheme is given below.

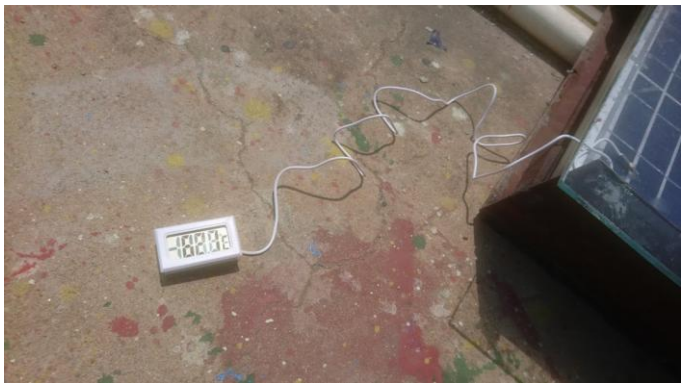


VII. DOUBLE-PASS PV/T AIR HEATERS

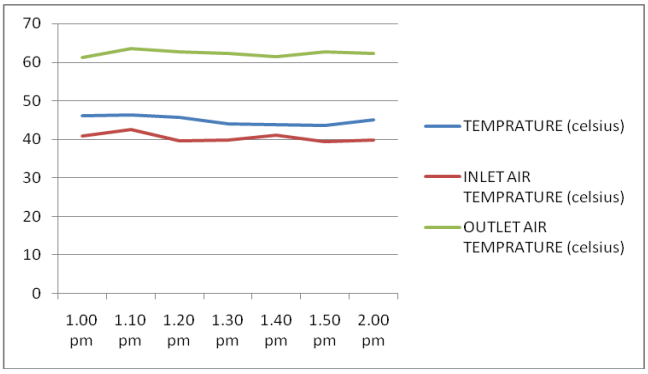
This project work involves the presentation investigation of twin-pass photovoltaic-thermal air collectors with slats. Air arrives through an upper layershaped by the glass cover and the photovoltaic panel is heated directly by the sun after it enters into the lower channel and this hot air is coming from lower channel because of this hot air so many uses for farmers and industries and solar panel efficiency is also increases and slats on the back of the photovoltaic panel increases the heat transfer to the air and by conducting heat to bottom plate and it is increases the efficiency of the system.

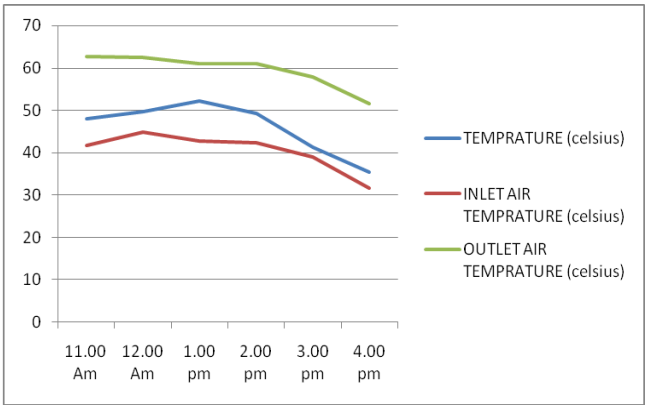


Double-pass PV/T hardware setup

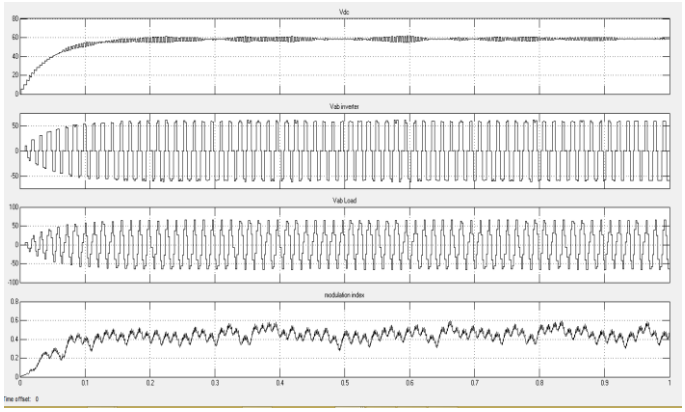


Double pass PV/T experimental results:





VIII. SIMULATION RESULTS



IX. CONCLUSION

This project planned a control scheme forinterrelated photovoltaic (PV) scheme. Battery and ultra-capacitors are used to retain the steadiness of the DC bus voltage. MPPT control algorithm is applied to the (PV) array.The investigationalconsequences show that the planned control plan is operative to deliver maximum power from PV array to the grid all time.

If the PV panels are mounted on good thermal conductivity materials (like aluminum), photo thermic and photovoltaic yield can be increased by increasing the heat dissipation to the working fluid. Slats provided at the back of absorber plate are increasing turbulence and there by thermal and electrical performance is improved and life of the PV cells can be increased by increasing cooling rate.

REFERENCES

1. AmeniKchaou, Aziz Naamane“Comparative Study of Different MPPT techniques for a Stand-alone PV System”2016.
2. Joe-Air Jianga, Yu-Li Sua, Kun-Chang Kuoa “On a hybrid MPPT control scheme to improve energy harvesting performance of traditional two-stage inverters used in photovoltaic systems”2017.
3. S. Palanikumar, Selvakumar.R, S. Sivakannan“Modern control scheme for Z-Source inverter based PV power generation systems”2018.
4. Wen long Jing, Derrick K.X. Ling, Chean Hung Lai “Hybrid Energy Storage Retrofit for Standalone Photovoltaic-Battery Residential Energy System”2017. IEEE Innovative Smart Grid Technologies - Asia (ISGT-Asia)
5. Yi Huang, Miaosen Shen, Student Member, IEEE, Fang Z. Peng, Fellow, IEEE, and Jin Wang, Member, IEEE“Z-Source Inverter for Residential Photovoltaic Systems”2006.
6. Zhixue Zheng , Xiaoyu Wang , Yong dong Li “A Control Method for Grid-friendly Photovoltaic Systems with Hybrid Energy Storage Units”2011,4th international conference on Electric utility DRPT-IEEE.
7. A Grid Connected Photovoltaic Inverter with Battery-Super capacitor Hybrid Energy Storage(Article).
8. PV cell basics from textbook (Muhammad. H.Rashid).

AUTHORS PROFILE

Dr. Pallani Kumar received B.E EEE from Manonmanium Sundaranar University in 98, M.E Power Electronics and Drives 2005 from Anna University, PHD from Anna University 2018

His field of interest are Power Electronics, Electric Drives, Electric Vehicles and Smart Grid