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HIGH-PERFORMANCE CONSTANT POWER GENERATION WITH FUZZY CONTROL OF GRID-CONNECTED PV SYSTEMS

[1]B KIRAN KUMAR ,[2]SHAIK HUSSAIN VALI

[1]M.Tech, JNTUA College of Engineering, Pulivendula, A.P, India.
Area of interest includes Power Systems, Switchgear and Protection,Electrical-Substations.

[2]Assistant Professor, JNTUA College of Engineering, Pulivendula, A.P, India.
Space of interest Electric Power System.

ABSTRACT : According to the paper we are improving the control technique which is developed for incremental method of the maximum power which connect with the PV systems and also fuzzy controller and it is proposed to make sure about the fast transition and smooth between the maximum power point tracking and constant power generation (CPG) which is also proposed control strategy to achieved the stable operation regarding the solar irradiance levels and high-performance. Which is used for regulate to PV output power along with the set point and it also force the PV system to operate at the left side of the MPP without any stability problem. Fuzzy controller is advance controller which is mostly suitable for the human decision making mechanism which also provided the operation of an electronic system with the expert decision. Here the fuzzy controller is compared with the another controller. By utilizing the fuzzy controller for a nonlinear system which allow the reduction for the uncertain effect in the system which control and perfectly improve the efficiency .by utilizing the simulation result we can determine the proposed CPG control in case of high accuracy, fast dynamics and stable transition.

INDEX TERMS—Active power control, constant power control, maximum power point tracking, PV systems, power converters fuzzy control.

INTRODUCTION

Maximum Power Point Tracking (MPPT) operation is required for framework associated PV frameworks with a specific end goal to expand the vitality yield. Providing food for more PV establishments requires to propel the power control conspires and in addition the directions with a specific end goal to maintain a strategic distance from antagonistic effects from PV frameworks like over-burdening the power matrix [1]– [3]. For example, in the German Federal Law: Renewable Energy Sources Act, the PV frameworks with the appraised control underneath 30 kWp must have the capacity to restrict the most extreme nourish in control (e.g. 70 % of the evaluated control) unless it can be remotely controlled by the utility [4]. Such a dynamic power control is alluded to as a Constant Power Generation (CPG) control or an outright power control like depicted in the Danish framework code. Basics of the CPG idea have been displayed in , which uncovers that the most financially savvy approach to accomplish the CPG control is by altering the MPPT calculation at the PV inverter level.

$$P_{pv} = \begin{cases} P_{MPPT,}\ when\ P_{pv} \leq P_{limit} \\ P_{MPPT,}\ when\ P_{pv} > P_{limit} \end{cases} \qquad (1)$$

In any case, when the yield control achieves Plimit, the yield energy of the PV framework will be kept steady, i.e., Ppv = Plimit, and prompting a consistent dynamic power infusion as appeared in (1) and represented in Fig. 1

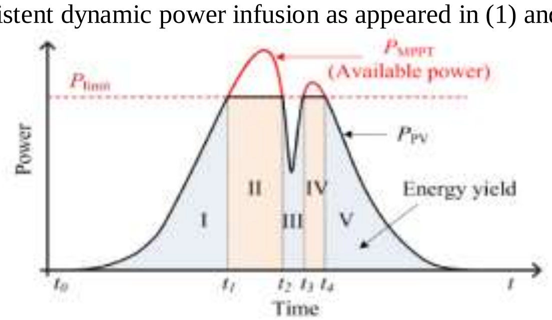

Fig. 1. Consistent Power Generation (CPG) idea: 1) MPPT mode amid I, III, V, and 2) CPG mode amid II, IV.

CONVENTIONAL CPG ALGORITHM

System Configuration

According to the Fig. 3 demonstrates the fundamental equipment setup of the two-organize single-stage matrix associated PV framework and its control structure. The CPG control is produced in the lift converter, which have been clarified.

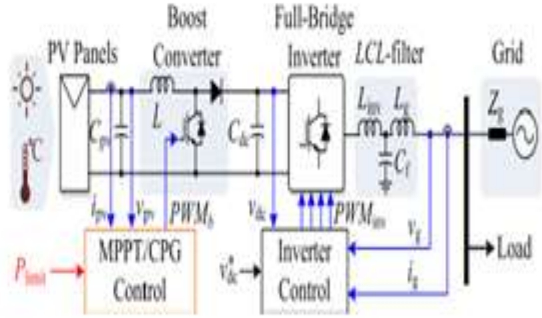

Fig. 3. Reproduction of schematic and general control structure of a two-arrange single stage network associated PV framework

The full-bridge inverter control is acknowledged by the cascaded control; here the DC-interface voltage is kept steady all through the control of the AC matrix current, which is an internal circle. a dynamic power is infused to the matrix, which implying that the PV framework works at a solidarity control factor. Not just that have been specified above and the two-organize setup can expand the working scope of both the MPPT and CPG calculations. In the two-organize case, the PV yield voltage vpv can be lower (e.g., at the left half of the MPP), and afterward it can be ventured up by the lift converter to coordinate the required DC-connect voltage (e.g., 450 V). This isn't the situation for the single-organize design, where the PV yield voltage vpv is straightforwardly bolstered to the PV inverter and must be higher than the network voltage level (e.g., 325 V)to guarantee the power conveyance .**Operational Principle**

The operational guideline of the regular P&O-CPG calculation is outlined in Fig. 4. It can be separated into two modes: a) MPPT mode (Ppv Plimit), where the P&O calculation should track the greatest power; b) CPG mode (Ppv > Plimit), where the PV yield control is restricted at Plimit. Amid the MPPT operation, the conduct of the calculation is like the traditional P&O MPPT calculation - the working point will track and sway around the MPP [13].

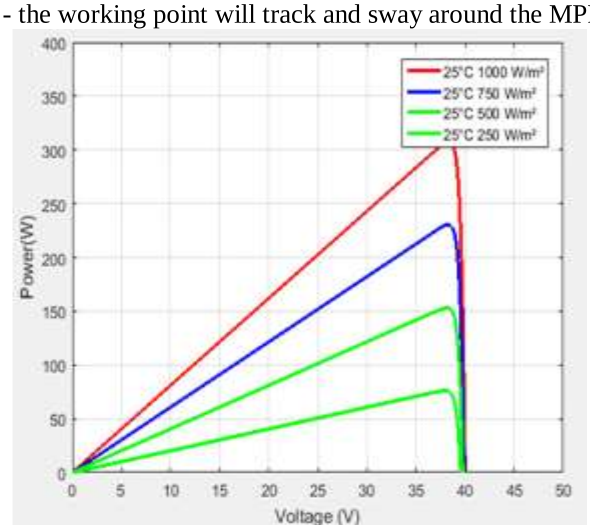

Fig. 4. Operational rule of the Perturb and Observe based CPG calculation (P&O-CPG), where the working point is directed to one side of the MPP considering security issues.

On account of the CPG operation, the PV voltage vpv is consistently irritated toward a point alluded to as Constant Power Point (CPP), i.e., Ppv = Plimit. After various cycles, the working point will reach and waver around the CPP. In spite of the fact that the PV framework with the P&O-CPG control can work at both CPPs, just the operation at the left half of the MPP (CPP-L) is engaged for the steadiness concern. The control structure of the calculation is appeared in Fig. 5, where v* pv can be communicated as

$$v^*_{PV} = \begin{cases} v_{MPPT}\,, & \text{when } P_{PV} \le P_{limit} \\ v_{pv,n-v_{step}} & ,\text{when} P_{PV} > P_{limit} \end{cases} \qquad (2)$$

Where vMPPT is the reference voltage from the MPPT calculation (i.e., the P&O MPPT calculation), vpv,n is the deliberate PV voltage, and vstep is the bother step measure.

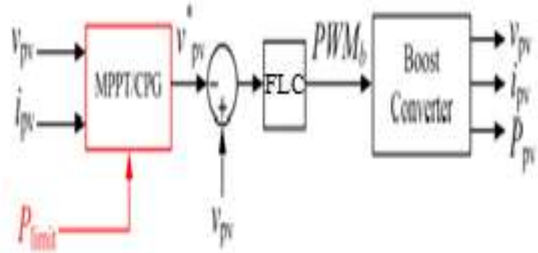

Fig. 5. Control structure of the Perturb and Observe based CPG calculation (P&O-CPG), where a Proportional Integrator (PI) is embraced.

Issues Of The P&O-CPG Algorithm

The P&O-CPG calculation has a fulfilled execution under moderate changing irradiance conditions, e.g., amid a crisp morning, when the working point is at the left half of the MPP, as appeared in Fig. 6(a). Nonetheless, irradiance variance that may occur in an overcast day will bring about overshoots and power misfortunes as appeared in Fig. 6(b).

Fig. 6. simulation results of the Perturb and Observe based CPG algorithm (P&O-CPG) under two daily conditions: (a) clear day and (b) cloudy day.

This can be additionally clarified utilizing the operation direction of the PV framework displayed in Fig. Expecting that the PV framework is working in MPPT mode at first and the irradiance level all of a sudden builds, the PV control Ppv is essentially lifted by the adjustment in the irradiance, as it can be seen from the dark bolt direction (i.e., A!B!C). As a result, substantial power overshoots may happen. Likewise, if the PV framework is working in the CPG operation (e.g., at CPP-L) and the irradiance abruptly drops, the yield control Ppv will make a sudden diminishing, as appeared in Fig. (i.e., CID). It will take various cycles until the point when the working point comes to the new MPP (i.e., E) at that irradiance condition (i.e., 200 W/m2), and bringing about loss of energy age.

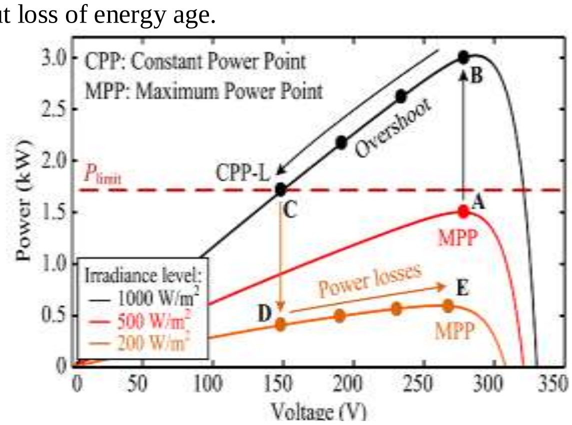

Fig. 7. Operating trajectory of the algorithm during a fast changing irradiance condition resulting in overshoot (black arrow) and power losses (orange arrow).

HIGH-PERFORMANCE P&O-CPG ALGORITHM

As indicated by the over, two fundamental assignments exist - limiting the overshoots and limiting the power misfortunes amid the quick changing irradiance condition which must be tended to on account of CPG operation. The proposed superior P&O-CPG calculation can successfully comprehend those issues. A. Limiting Overshoots Increasing the annoyance step measure is a probability to limit the overshoots as the following rate is expanded. In particular, an extensive advance size can decrease the required number of emphasess to achieve the comparing CPP. Strikingly, the progression estimate alteration ought to be empowered just when the calculation recognizes a quick increment in the Irradiance Condition (IC), which can be delineated as

$$IC = \begin{cases} 1, & \text{when } P_{PV,n} - P_{limit} > \epsilon_{inc} \\ 0 & ,\text{when} P_{PV,n} - P_{limit} \leq \epsilon_{inc} \end{cases} \quad (3)$$

with Ppv,n being the deliberate PV control at the present examining, and "inc being the foundation, which ought to be bigger than the unfaltering state control swaying of the PV boards. At the point when a quick increment in the IC is distinguished (i.e., IC = 1), a versatile advance size is then utilized, where the progression estimate is computed in view of the distinction amongst Plimit and Ppv,n as it is given in (4). Thusly, the extensive advance size will be utilized at first and the progression size will ceaselessly be lessened as the working point ways to deal with the CPP.

$$v^*_{PV} = v_{pv,n} - \left[(P_{pv,n} - P_{limit}) \frac{P_{limit}}{P_{mp.\gamma}} \right] .v_{step} \quad (4)$$

where vpv is the reference yield voltage of the PV clusters, vpv,n and Ppv,n are the deliberate yield voltage and energy of the PV exhibit at the present testing, separately. Pmp is the appraised control. Vstep is the first step size of the P&O-CPG calculation. The term Plimit=Pmp is acquainted with lighten the progression estimate reliance in the level of Plimit. is a consistent which can be utilized to tune the speed of the calculation.

Limiting Power Losses

As clarified in Fig. at the point when the CPG working point is at the left half of the MPP, the P&O-CPG calculation requires various cycles to come to the new MPP amid a quick expire in irradiance, prompting power misfortunes. Actually, the working purpose of the PV framework does not change much if the PV framework is working in the MPPT under various irradiance levels as appeared in Fig. 8. Remarkably, the identification of the diminished IC and in addition the Previous Operating Mode (POM) is additionally critical for limiting the power misfortunes:

$$IC = \begin{cases} 1, & \text{when } P_{PV,n-1} - P_{pv,n} > \varepsilon_{dec} \\ 0 & ,\text{when} P_{PV,n-1} - P_{pv,n} \leq \varepsilon_{dec} \end{cases} \quad (5)$$

$$POM = \begin{cases} CPG, & \text{when } \left| P_{limit} - P_{PV,n-1} \right| > \varepsilon_{ss} \\ MPPT & ,\text{when} \left| P_{limit} - P_{PV,n-1} \right| \leq \varepsilon_{ss} \end{cases} \quad (6)$$

where "dec and "ss are criteria to decide the quick irradiance diminish and the CPG working mode, individually. Ppv,n-1 is the deliberate PV control at the past examining. For instance, the estimation of "ss can be picked as 1-2 % of the evaluated energy of the PV framework, which is typically higher than the relentless state mistake in the PV energy of the P&O-CPG calculation. At the point when a quick lessening (i.e., IC = 1) is identified amid the CPG to MPPT change as indicated by (6), a steady voltage given by (7) is connected to the PV framework with a specific end goal to quicken the following pace (i.e., limit the power misfortunes). The steady voltage can be approximated as 71-78 % of the open circuit voltage VOC, as represented in Fig. 7.

$$v^*_{pv} = k.V_{OC}, where\ 0.71 \leq k < 0.78 \quad (7)$$

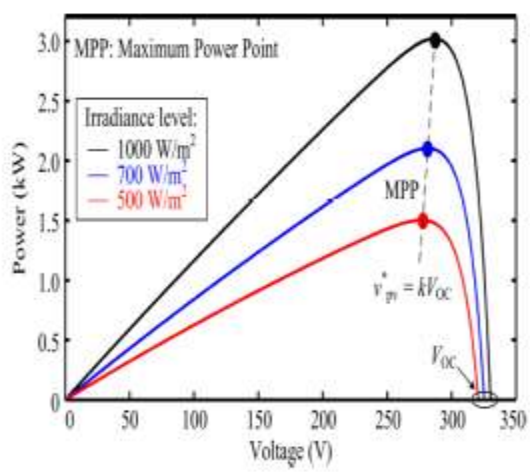

Fig. 8. Power-voltage (P-V) curves of the PV arrays, where the voltage at the MPP is almost constant especially at a higher irradiance level .

Thusly, the working point can be immediately moved near the MPP in one annoyance, bringing about a noteworthy lessening in the quantity of cycles until the point that the working point comes to the MPP. This approach is straightforward yet compelling, which is exceptionally appropriate to be executed.

III. FUZZY LOGIC CONTROLLER

In FLC, essential control activity is dictated by an arrangement of phonetic standards. These standards are controlled by the framework. Since the numerical factors are changed over into semantic factors, scientific displaying of the framework isn't required in FC.

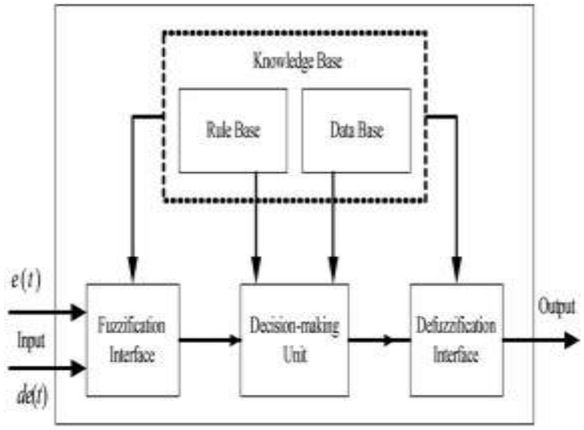

Fig.9.Fuzzy logic controller

The FLC involves three sections: fuzzification, obstruction motor and defuzzification. The FC is described as I. seven fluffy sets for each info and yield. ii. Triangular enrollment capacities for effortlessness. iii. Fuzzification utilizing consistent universe of talk. iv. Suggestion utilizing Mamdani's, 'min' administrator. v. Defuzzification utilizing the tallness strategy.

TABLE I: Fuzzy Rules

Change in error	Error						
	NB	NM	NS	Z	PS	PM	PB
NB	PB	PB	PB	PM	PM	PS	Z
NM	PB	PB	PM	PM	PS	Z	Z
NS	PB	PM	PS	PS	Z	NM	NB
Z	PB	PM	PS	Z	NS	NM	NB
PS	PM	PS	Z	NS	NM	NB	NB
PM	PS	Z	NS	NM	NM	NB	NB
PB	Z	NS	NM	NM	NB	NB	NB

Fuzzification: Enrollment work esteems are doled out to the etymological factors, utilizing seven fluffy subsets: NB (Negative Big), NM (Negative Medium), NS (Negative Small), ZE (Zero), PS (Positive Small), PM (Positive Medium), and PB (Positive Big). The Partition of fluffy subsets and the state of enrollment CE(k) E(k) work adjust the take care of business to fitting framework. The estimation of information mistake and change in blunder are standardized by an info scaling factor. In this framework the information scaling factor has been outlined with the end goal that information esteems are between - 1 and +1. The triangular state of the participation capacity of this plan presumes that for a specific E(k) contribution there is just a single predominant fluffy subset. The information blunder for the FLC is given as

$$E(k) = \frac{P_{ph(k)} - P_{ph(k-1)}}{V_{ph(k)} - V_{ph(k-1)}} \quad (8)$$

$$CE(k) = E(k) - E(k-1) \quad (9)$$

Inference Method: A few arrangement strategies, for example, Max– Min and Max-Dot have been proposed in the writing. In this paper Min technique is utilized. The yield enrollment capacity of each control is given by the base administrator and greatest administrator. Table 1 demonstrates control base of the FLC.

Defuzzification: As a plant more often than not requires a non-fluffy estimation of control, a defuzzification arrange is required. To register the yield of the FLC, „height" strategy is utilized and the FLC yield alters the control yield. Further, the yield of FLC controls the switch in the inverter. In UPQC, the dynamic power, receptive power, terminal voltage of the line and capacitor voltage are required to be kept up. Keeping in mind the end goal to control these parameters, they are detected and contrasted and the reference esteems. To accomplish this, the enrollment elements of FC are: mistake, change in blunder and yield

The set of FC rules are derived from

$$u=-[\alpha E + (1-\alpha)*C] \quad (10)$$

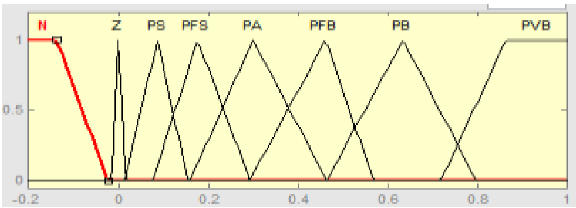

Fig 10 input error as membership functions

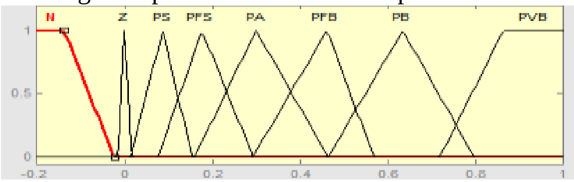

Fig 11 change as error membership functions

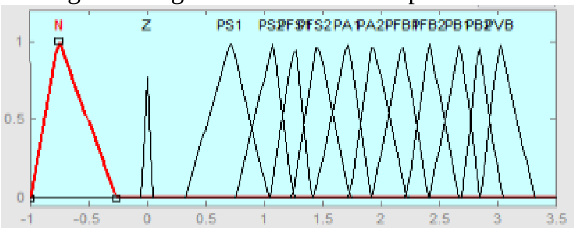

Fig.12 output variable Membership functions

Where α is self-adjustable factor which can regulate the whole operation. E is the error of the system, C is the change in error and u is the control variable.

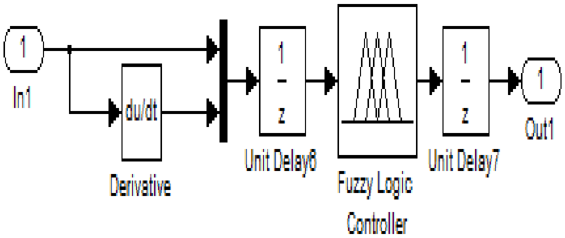

Fig 13.fuzzy logic controller in simulation

SIMULATION VERIFICATION

Solutions to improve the dynamic execution of the P&OCPG calculation have been examined previously. Parameters of the proposed superior P&O-CPG calculation are composed as: = 10, k = 0.715, "inc = 50 W, "dec = 100 W, and "ss = 30 W. Reenactment are done alluding to Fig. 3, and the framework parameters are given in Table II.

Table II

Parameters Of The Two-Stage Single-Phase Pv System

Boost converter inductor	$L = 1.8$ mH
PV-side capacitor	$C_{pv} = 1000\ \mu$F
DC-link capacitor	$C_{dc} = 1100\ \mu$F
LCL-filter	$L_{inv} = 4.8$ mH, $L_g = 4$ mH, $C_f = 4.3\ \mu$F
Switching frequency	Boost converter: $f_b = 16$ kHz, Full-Bridge inverter: $f_{inv} = 8$ kHz
DC-link voltage	$V_{dc} = 450$ V
Grid nominal voltage (RMS)	$V_g = 230$ V
Grid nominal frequency	$\omega_0 = 2\pi \times 50$ rad/s

In the reproduction, a 3-kW PV test system has been embraced, where genuine field sunlight based irradiance and surrounding temperature profiles are customized. Fig. 8 demonstrates the execution of the proposed elite P&O-CPG strategy with two genuine field day by day conditions. Rather than the traditional P&O-CPG strategy (appeared in Fig. 6), the overshoots and power misfortunes are fundamentally diminished by the proposed arrangement and a steady operation is additionally kept up. The calculation additionally has a specific conduct to just respond, when the quick irradiance condition is identified. This can be seen from the execution under clear irradiance conditions in Fig. 12(a), which is like the traditional P&O-CPG calculation (appeared in Fig. 6(a)).

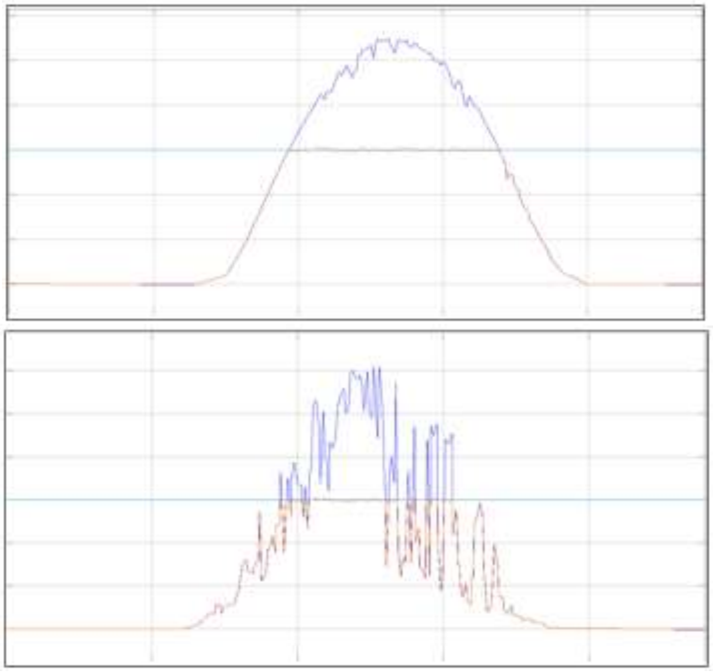

Fig.14. simulation results of the proposed high-performance P&O-CPG algorithm under two daily conditions: (a) clear day and (b) cloudy day.

CONCLUSION

In this paper watched that a superior dynamic power control plot been constraining the greatest power which is nourish to the PV frameworks which is proposed there. The proposed arrangement ensure about the steady consistent power age operation. At the point when contrasted and the conventional techniques. Here the proposed control methodology will powers the PV frameworks to work at the left half of the greatest power point, and which make to accomplish a steady operation alongside smooth changes. In FLC, essential control activity is dictated by an arrangement of semantic principles. These tenets are controlled by the framework. Since the numerical factors are changed over into etymological factors, scientific displaying of the framework isn't required in FC. Reenactment have confirmed the viability of the proposed control arrangement with a specific end goal to limited power misfortunes, diminished overshoots and furthermore quick elements. In addition for single-arrange PV frameworks, same idea of CPG is likewise pertinent. In this way in such case, the PV voltage working extent will restricted and some little changes in the calculations which are important to ensure for a steady operation.

REFERENCES

[1] T. Stetz, F. Marten, and M. Braun, "Enhanced low voltage grid integration of photovoltaic frameworks in Germany," IEEE Trans. Manage. Vitality, vol. 4, no. 2, pp. 534– 542, Apr. 2013.
[2] A. Ahmed, L. Ran, S. Moon, and J.- H. Stop, "A quick PV control following control calculation with diminished power mode," IEEE Trans. Vitality Conversion, vol. 28, no. 3, pp. 565– 575, Sept. 2013.
[3] Y. Yang, H. Wang, F. Blaabjerg, and T. Kerekes, "A cross breed control idea for PV inverters with lessened warm stacking," IEEE Trans. Power Electron., vol. 29, no. 12, pp. 6271– 6275, Dec. 2014.
[4] German Federal Law: Renewable Energy Sources Act (Gesetz hide sanctum Vorrang Erneuerbarer Energien) BGBl, Std., July 2014.
[5] Energinet.dk, "Specialized direction 3.2.5 for wind control plants with a power yield more noteworthy than 11 kw," Tech. Rep., 2010.
[6] Y. Yang, F. Blaabjerg, and H. Wang, "Steady power age of photovoltaic frameworks considering the disseminated network limit," in Proc. of APEC, pp. 379– 385, Mar. 2014.
[7] R. G. Wandhare and V. Agarwal, "Exact dynamic and responsive power control of the PV-DGS coordinated with frail framework to build PV entrance," in Proc. of PVSC, pp. 3150– 3155, Jun. 2014.
[8] W. Cao, Y. Mama, J. Wang, L. Yang, J. Wang, F. Wang, and L. M. Tolbert, "Two-organize PV inverter framework emulator in converter based power lattice imitating framework," in Proc. of ECCE, pp. 4518– 4525, Sept. 2013.
[9] A. Urtasun, P. Sanchis, and L. Marroyo, "Restricting the power produced by a photovoltaic framework," in Proc. of SSD, pp. 1– 6, Mar. 2013.

[10] S. B. Kjaer, J. K. Pedersen, and F. Blaabjerg, "A survey of single-stage framework associated inverters for photovoltaic modules," IEEE Trans. Ind. Appl., vol. 41, no. 5, pp. 1292– 1306, Sept. 2005.
[11] F. Blaabjerg, R. Teodorescu, M. Liserre, and A. V. Timbus, "Outline of control and framework synchronization for conveyed control age frameworks," IEEE Trans. Ind. Electron., vol. 53, no. 5, pp. 1398– 1409, Oct. 2006.
[12] B. Yang, W. Li, Y. Zhao, and X. He, "Plan and examination of a gridconnected photovoltaic power framework," IEEE Trans. Power Electron., vol. 25, no. 4, pp. 992– 1000, Apr. 2010.
[13] T. Esram and P. L. Chapman, "Examination of photovoltaic exhibit greatest power point following techniques,"IEEE Trans. Vitality Convers., vol. 22, no. 2, pp. 439– 449, Jun. 2007.