IMPLEMENTATION OF ANTI-WINDUP PI CONTROLLER FOR ACTIVE POWER CONTROL WITH MODIFIED P&O STRATEGY FOR HYBRID POWER GENERATION SYSTEM

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ABSTRACT

This paper discusses about the power generation and stabilized quality power transmission from the multiple renewable energy resources utilizing the wind, solar PV (SPV) array and battery system implementing the anti-windup PI controller for active power control making use of P&O strategy in lining with sliding mode control (SMC). The hybrid power generation (HPG) system is designed for high performance with reduced number of switches and sensors for stand-alone operation which implements the 5-level Cascaded H-bridge inverter on DCAC conversion section for added performance and THD improvement. The HPG system is simulated in Matlab software for its effectiveness in detailed stability analysis, and various operating conditions for trajectories in SMC of many power converters installed within.

I.INTRODUCTION

A few far-off territories on the planet utilize just diesel generators (DGS) to help their power needs. This fuel source (ES) is exorbitant and contamination. Be that as it may, a cross breed independent power generation framework (HSPGS) in view of wind and sun based energy upheld by the battery energy stockpiling framework (BESS) is considered as a promising answer for far off zones to lessen diesel-fuel reliance, to limit the nursery (GHS) discharges, to diminish power transmission, and to limit the framework misfortunes [1]. This new innovation is viable; notwithstanding, it requires improvement, particularly in the plan and control to get straightforward and simple to utilize. ESS is proposed in the writing [2]. In the majority of the proposed arrangements [3], [4], multistage converters are utilized to associate the appropriated energy assets (DERs) to the point of normal coupling (PCC), which prompts an expansion in energy misfortunes and the expense of establishment. In [5], AC dc microgrid setup is proposed to interface the DERs to the PCC. The creators have prevailing with regards to accomplishing their destinations; be that as it may, this recommendation isn't approved progressively. For the most part, single or two-stage converters are utilized to associate the PCC and the sun oriented photovoltaic exhibit (SPVA) [6]. In [7], a solitary stage framework is proposed and acquired outcomes show agreeable execution. As per [7]–[9] and the near examination acknowledged in [10], two-stage framework shows elevated level of execution, particularly in dc voltage solidness and power quality.

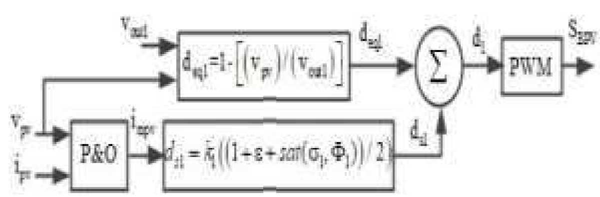
With respect to productivity of SPVA, and wind turbines (WTs), numerous techniques are created in the writing to follow the maximum power point (MPP) [11], [12]. Contrasted with the current MPP following (MPPT) techniques, bother and perception (P&O) is broadly applied as a simple strategy. Shockingly, this strategy experiences the persistent swaying that happens around the MPP. What's more, it loses the following heading during unexpected changes in climate conditions. These downsides are fathomed in [13] by restricting the control utilizing dynamic limit conditions. This arrangement is successful; notwithstanding, it requires improvement particularly in demonstrating and solidness investigation. In [14], an improved beta-P&O strategy is proposed to illuminate the downsides of the old style P&O technique. This arrangement is perplexing and its elements are moderate. Besides, it requires enormous run time since it utilizes two phases: 1) versatile scaling factor beta to get an elevated level of execution during transient reaction, and 2) zero motions P&O strategy for consistent state mistake. [15] Have introduced improvement in the exhibition of traditional P&O by utilizing delta-P&O, PIP& O, just as ZA-P&O techniques, be that as it may, with convoluted control and equipment unpredictability. In a similar setting, cross breed simple advanced sliding mode regulator (SMC) is introduced for P&O strategy in [16] to accomplish superior, particularly during climate changes, and for optimizing, the P&O-based SMC is utilized in [17]. In [18], the tip-speed proportion based SMC has been proposed for variable speed WTs. A similar methodology is applied in [19]–[21] with definite dependability examination and regulator picks up count. In every one of these examinations [9], [16]–[21], effective approval of SMC-based MPPT for SPVA and variable speed WTs, on equipment model is introduced and gotten results show agreeable execution. Be that as it may, these SMC based MPPT techniques [9], [16]–[21] are applied and approved for straightforward frameworks utilizing just a single DER with a decreased number of intensity converters, where the jabbering marvel because of high exchanging recurrence is anything but a major issue.In a HSPGS, voltage and recurrence are directed by controlling the dc–AC interfacing inverter utilizing fitting control system, for example, versatile voltage control [22] or the new fluffy versatile voltage regulator [23]. The introduced outcomes have indicated palatable execution anyway they require extra sensors and are unpredictable to actualize. In a similar setting, improved hang control technique is proposed for simple usage progressively. Tragically, in completely proposed control methodologies the internal and external circles are utilized in traditional PI regulators and as far as possible are thought of, which isn't sufficient to forestall wrap up when the framework surpasses its physical cutoff points. In such cases, the criticism circle is broken and the framework runs as an open circle.

II.PROPOSED METHOD

Fig.1 shows the proposed HSPGS configuration for isolated areas that possess a good wind and solar potential.. It comprises of SPVA, WT-driven variable speed perpetual magnet brushless dc generator (PMBLDCG), BESS, two boost converters, a three-stage diode rectifier, interfacing dc–AC power inverter, LC low-pass channel, loads, and a dc dump load. To keep away from the synchronization issues, all DERs are associated with the dc bus. Three control procedures are created to guarantee steady and full of feeling activity of HSPGS under cut off conditions.

A. Modeling and Control Design for SPVA

1) Control strategy for the Boost converter-1 The control scheme of the improved P&O method based on SMC with boundary layer is shown in Fig.2, which is used to achieve high performance from SPVA and to ensure stability during sudden changes in solar insolation in finite time.



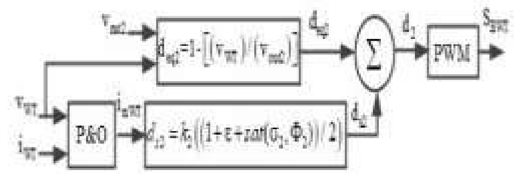


Fig. 3. Improved P&O based SMC with boundary layer for WT

C. Modeling and control design of th ree-

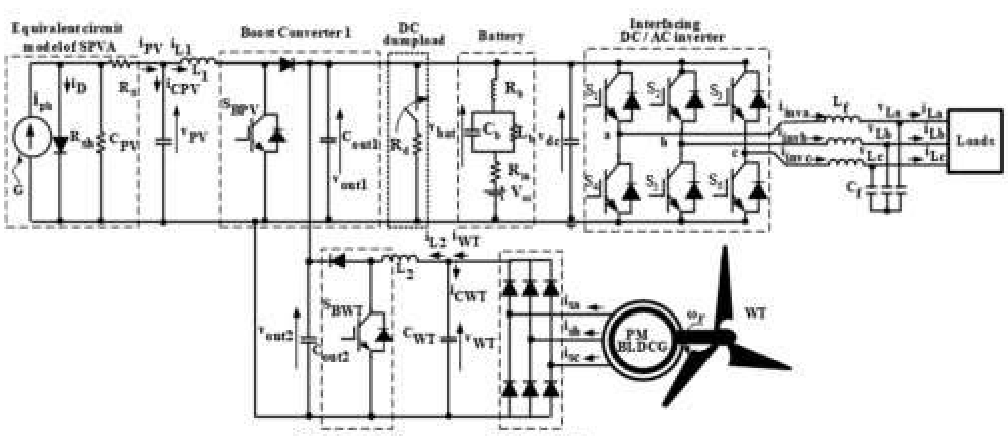


Fig. 1. HSPGS configuration under study

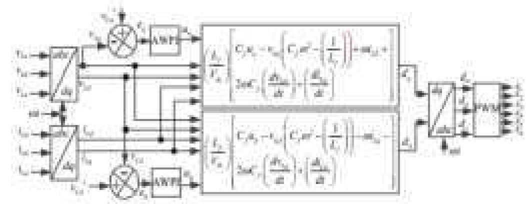


Fig. 2. Improved P&O based SMC with boundary layer for SPVA.

2) Control strategy for boost converter-2
An improved P&O method based SMC with boundary layer, is presented in Fig.3, which is developed to achieve high performance from WT driven variable speed PMBLDCG without mechanical sensors. It is also used to ensure stability at the operating point in finite time, during sudden change in wind speed. For this method, only output (vout2) and input (vWT) DC voltages and the inductor current (iL2) which is equal to the output WT current (iWT), are sensed to obtain the desired control d2.

phase inverter
Fig.4 shows the control scheme of the APC based on AWPI controller for the AC voltage regulation. The system frequency is maintained constant by operating the DC-AC interfacing inverter at 60Hz. Applying Kirchhoff's voltage and current laws at the connection point of the three-phase interfacing inverter shown in Fig.1.

Fig. 5 Block diagram of the AWPI controller with feedback path control for d and q axis.

III.SIMULATION RESULTS

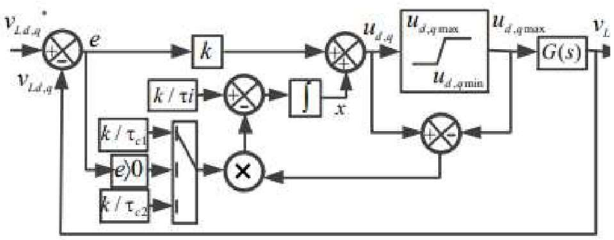
Performance of the APC based AWPI controller and improved P&O based SMC with boundary layer developed in this work are simulated under severe conditions using Matlab/Simulink.

A. Performance of improved P&O based SMC with boundary layer for WT and SPVA under weather change

A.a) obtained results of improved P&O based SMC with boundary layer WT side and b) SPVA

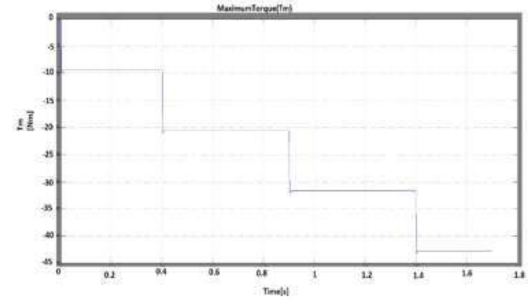
Fig. 4 APC based AWPI controller for DC - AC interfacing inverter.

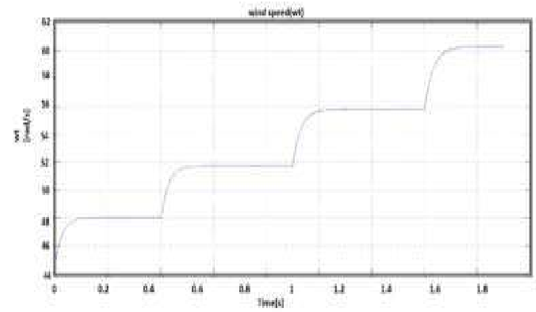
Fig.5shows the block diagram for AWPI controller with feedback path control for d and q axis to avoid the saturation problem. The AWPI controller model is based on time constants τc and τi, as well as, the gain k, which have a visible effect on system performance when saturation occurs. Therefore, to get high performance, optimal gains design is required.



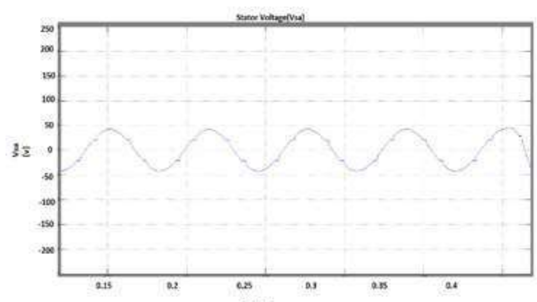
i)Maximum torque(T_m)

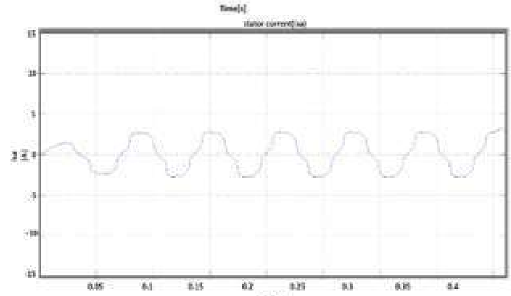
iii)Stator voltage(v_{sa})



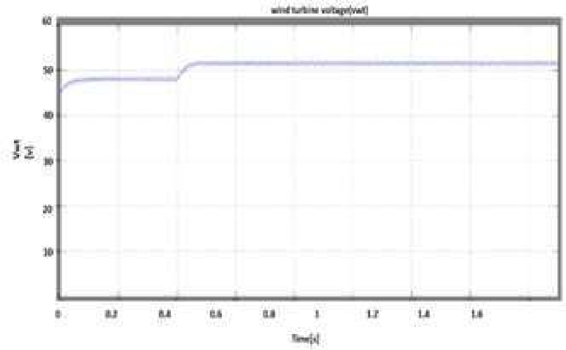


ii)Wind speed(w_t)

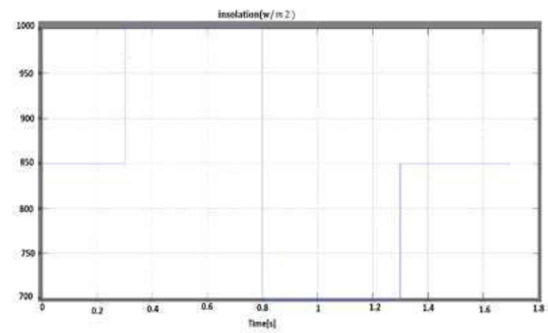




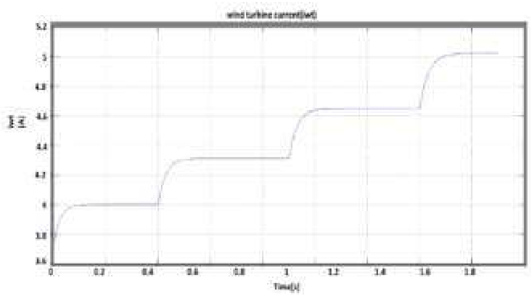
iv)stator current(i_{sa})



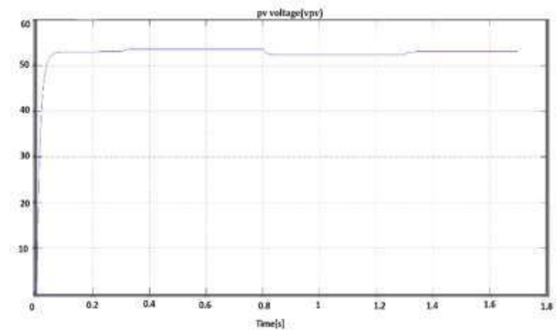
v)Wind turbine voltage(v_{wt})



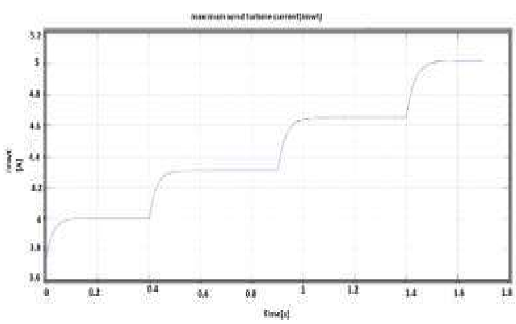
ix) Insolation(w / m^2)



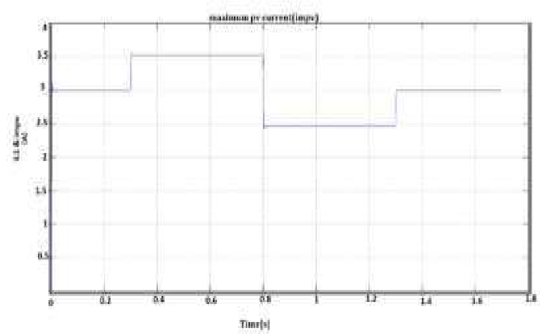
vi)Wind turbine current(i_{wt})



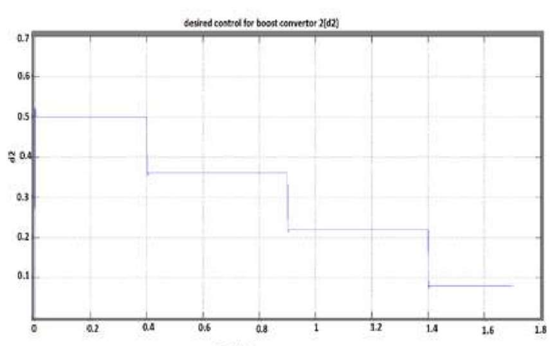
x) PV voltage(v_{pv})



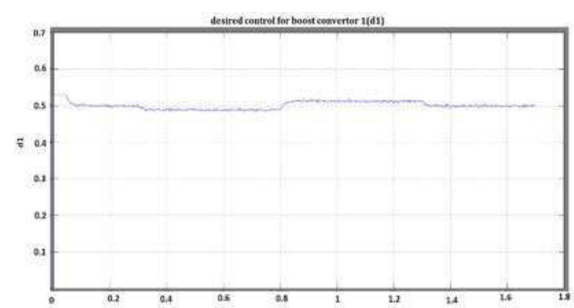
vii)maximum wind turbine current(i_{mwt})



xi) Maximum pv current(i_{mpv})



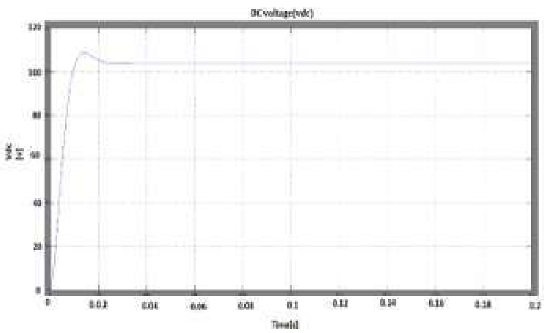
viii)Desired control (d_2)



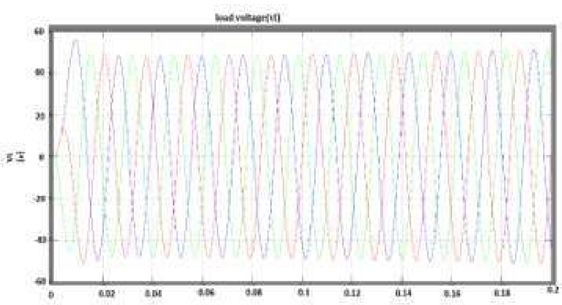
xii)desired control (d_1)

B..Performance of APC with AWPI

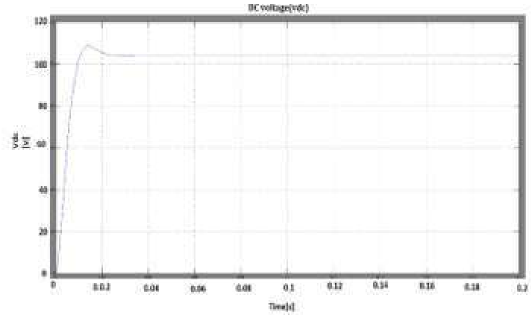
under different type of loads a) Steady state



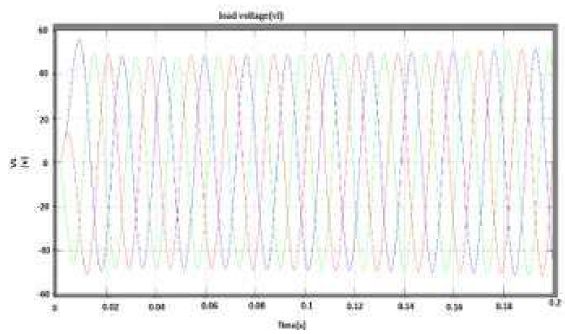
i)Dc voltage(v_{dc})



b) sudden increased of load at t=0.1 s, controller

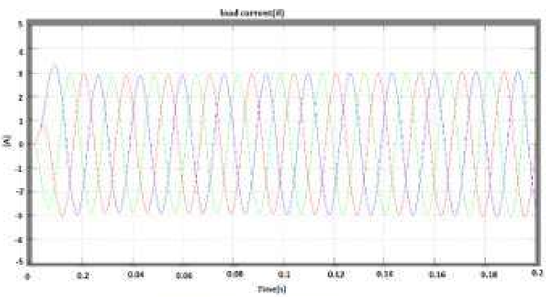


i) voltage(v_{dc})

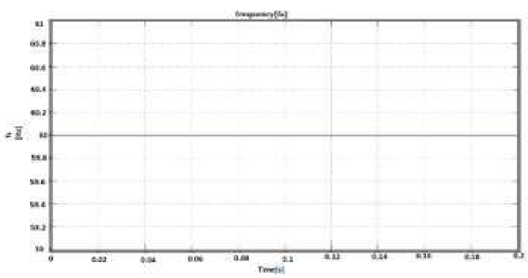


ii) load voltage(v_l)

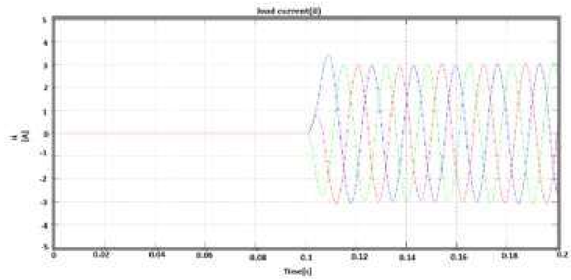
ii)Load voltage(v_{dc})

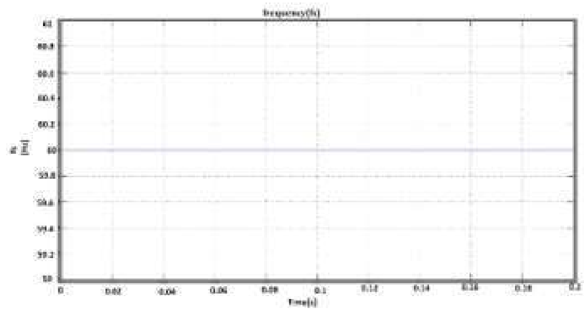


iii)load current(il)



iv)Frequency(f_s)

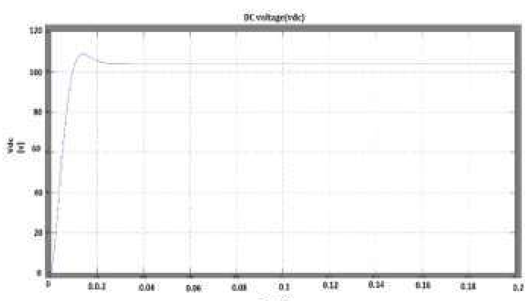




iii)load current(i_l)

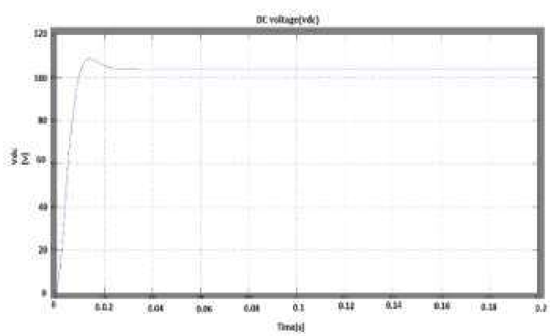
iv) Frequency(f_s)

c) unbalance linear load

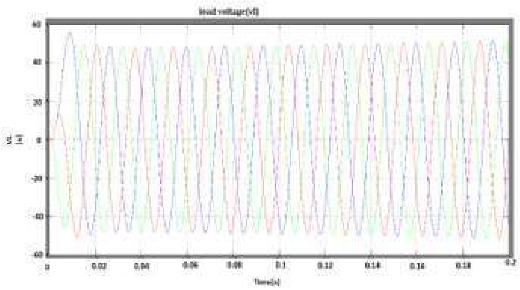


i) voltage(v_{dc})

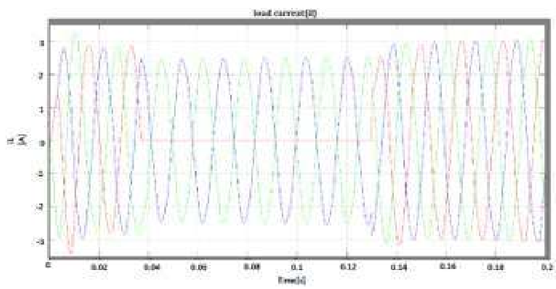
d) balanced and unbalanced nonlinear load

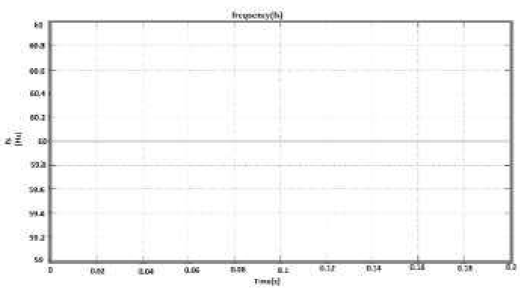


i)Dc voltage(v_{dc})

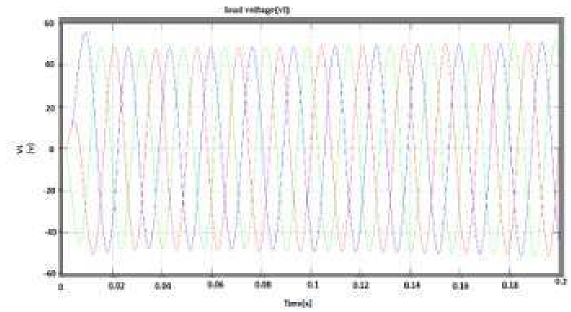


ii) load voltage(v_l)



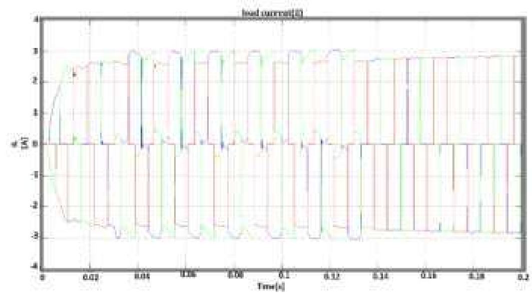


iv)frequency(f_s)

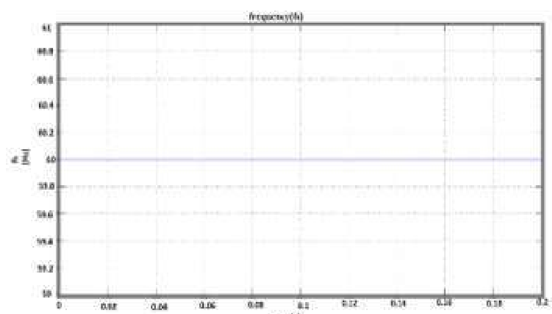


ii)load voltage(v_l)

iii) Load current(i_l)



iii)Load current(i_l)



iv)frequency(fs)

VI.CONCLUSION:

For standalone use, a wind-PV-battery hybrid power generation system has been proposed. Modeling, control design, and stability analysis have all been thoroughly discussed. The system's simulated performance was obtained using an improved P&O method for MPPT of SPVA and WT. SMC with boundary layer is designed for improved performance under variable weather conditions in a multiple source power generation system. It has been demonstrated that the improved P&O-based MPPT is more reliable and efficient during weather changes when multiple power converters are operating concurrently. Furthermore, it has been demonstrated that the APC with AWPI voltage controller regulates constant and sinusoidal AC voltage during transients without saturation or overshoot.

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