ANFIS BASED HYBRID POWER GENERATION FED GRID BY USING BACK-TO-BACK VSI

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ABSTRACT: The topography presented in this paper is straightforward and efficient for a network-connected wind photovoltaic (PV) cogeneration device. Through one-after-the-other (BtB) voltage-source converters (VSCs), a full-scale wind turbine primarily based on a super durable magnet simultaneous generator is interfaced to the application network. The dc-link capacitor of the BtB VSCs instantly identifies a PV sun-oriented generator. The device's performance is improved because no dc/dc change degrees are needed. To increase the extraction of the limitless power, the planned geography incorporates an autonomous most extreme force point observing system for both wind and PV turbines. The vector control conspire in the pivoting reference body is how the law of the VSCs is implemented. The purpose of the particular little sign inquiry for the device's additional chemicals is to analyze the overall balance. Additionally, the impact of the utility-network defects on the display of the suggested device is evaluated. The findings of nonlinear time-region reenactment reveal specific working conditions that are presented to validate the suitability of the suggested geography.

KEYWORDS: adaptive-neuro fuzzy interfaced system (ANFIS), wind, solar, VSC.

I.INTRODUCTION: Over the past ten years, the cost of producing electricity from solar and wind has been steadily declining. The installed capacity of wind and photovoltaic (PV) generators worldwide has increased from 6 GW and 74 GW in 2006 to about 303 GW and 487 GW in 2016, respectively, thanks to their financial and technological incentives [1]. Because wind and solar energy are erratic and uncontrolled, power-electronic converters are used as a step of interface to the utility grid or load-side, leading to the creation of distributed generation units [2]–[3]. The majority of distributed generating systems in the literature are only used for one type of renewable resource, such as wind energy in [6]–[8] or solar energy in [4]–[5]. Combining solar and wind energy in the same area has been explored as a way to optimize the advantages of the renewable resources that are currently accessible. The following traits are present in wind and solar energy cogeneration:

1) The availability of the wind and solar energy is generally complementary, and

hence combining both forms of energy increases the overall operational efficiency.
2) The combination of the wind and solar co-generators optimizes the utilization of lands resources, and hence improves the capital investments.
3) As compared to the static PV generators, the wind-solar cogeneration systems are more dynamically capable to support the utility-grid due to the available moment of inertia in the mechanical system of the wind generators [8].
4) Having two sources of energy increases the generation reliability [9]- [10]. The grid-connected wind-PV cogeneration systems are not widely addressed. On the contrary, several wind-PV cogeneration systems are proposed for the standalone off-grid applications. A standalone wind-PV cogeneration system is proposed. On the small-scale level, a single-phase cogeneration system has been proposed in [18] whereas a laboratory-scale system is introduced. Generally, the system structure comprises a common dc-bus that interfaces several parallel connected converters-interfaced renewable energy resources, which might reduce the overall system efficiency and increase the cost [12]. More importantly, the cascaded connection of power converters requires rigorous controllers coordination to avoid the induced interactions dynamics, which might yield instabilities [25]-[26]. A back-to back (BtB) voltage-source converter (VSC) connected to a doubly-fed induction generator is used to interface a dc-dc converter-interfaced PV generator and an energy storage unit in [21]. In [22], a PV generator charging a battery bank and interfaced to a wind driven induction generator via a VSC is proposed. The wind-PV cogeneration systems in [21]-[22] highlights the efficient integration of the renewable energy resources with the minimal utilization of power-electronic conversion stages. However, these systems are proposed for specific off-grid applications. In [12]-[14], the utility-grid integration of the renewable energy resources has been improved by using multiple-input converters. A buck/buck-boost fused dc-dc converter is proposed in [12]. A dc-dc converter with a current-source interface, and a coupled transformer is proposed in [13] and [14], respectively. However, the proposed systems are based on the dc power distribution which might not be the ideal distribution medium in the ac-dominated power systems. Up to the authors' best knowledge, the combination of the grid-connected wind-PV systems has been solely addressed. The system comprises a BtB VSCs to interface the PV and wind generators to the utility-grid. On the machine-side- VSC, the dc-link voltage is regulated to the maximum power point tracking (MPPT) value of the PV panels by an outer loop proportional-and-integral (PI) dc voltage controller. The reference values of the machine-side currents are calculated using the synchronous detection method, and a hysteresis current controller is utilized for the regulation. On the grid-side-VSC, a hysteresis grid-current controller is used to inject the total currents into the utility-grid. In spite of the potential benefits of the proposed system in [15], the following challenges are noted; 1) the MPPT of either the PV and wind power involves the operation of both VSCs, which in some

cases might decreases the system reliability and increases the losses. For instance, if the wind velocity is lower than the cut-off speed of the wind turbine, i.e., no wind power, the machine-side VSC may be unable to track the solar PV MPPT dc-link voltage [15]. 2) The currents of the machine and grid-side converters are regulated using hysteresis controllers resulting in a variable switching frequency and higher harmonic contents. Motivated by the promising benefits of the wind-PV generation systems, this paper introduces a new topology, yet simple and efficient to interface both the wind and PV generators into the utility-grid. The contributions of this paper are as following;

1) The realization of the grid-connected wind-PV cogeneration system using BtB VSCs with no extra dc/dc conversion stages.

2) Independent MPPT operation where the MPPT of the wind and PV generators is solely achieved by the voltage-source rectifier (VSR), and the voltage-source inverter (VSI), respectively.

3) The development of the complete small-signal state-space model of the wind-PV cogeneration system to characterize the overall system stability.

4) The performance of proposed system has been investigated under different operating conditions, including the utility grid faults, using time-domain simulations.

II.LITARATURE SURVEY:

F. Blaabjerg, Z. Chen, and S. B. Kjaer, are proposed The global electrical energy consumption is rising and there is a steady increase of the demand on the power capacity, efficient production, distribution and utilization of energy. The traditional power systems are changing globally, a large number of dispersed generation (DG) units, including both renewable and nonrenewable energy sources such as wind turbines, photovoltaic (PV) generators, fuel cells, small hydro, wave generators, and gas/steam powered combined heat and power stations, are being integrated into power systems at the distribution level. Power electronics, the technology of efficiently processing electric power, play an essential part in the integration of the dispersed generation units for good efficiency and high performance of the power systems. This paper reviews the applications of power electronics in the integration of DG units, in particular, wind power, fuel cells and PV generators.

A. Yazdani and P. P. Dash, are proposed a control strategy for a single-stage, three-phase, photovoltaic (PV) system that is connected to a distribution network. The control is based on an inner current-control loop and an outer DC-link voltage regulator. The current-control mechanism decouples the PV system dynamics from those of the network and the loads. The DC-link voltage-control scheme enables control and maximization of the real power output. Proper feed forward actions are proposed for the current-control loop to make its dynamics independent of those of the rest of the system. Further, a feed forward compensation mechanism is proposed for the DC-link voltage-control loop, to make the PV system dynamics immune to the PV array nonlinear characteristic. This, in turn, permits the design and optimization of the PV system controllers for a wide range of operating conditions.

III.PROPOSED SYSTEM CONFIGARATION:

As shown in Fig. 1, the proposed system consists of a VSR to interface the wind generator, and a VSI to connect the cogeneration system into the utility-grid. The PV generator is directly connected to the dc-link capacitor of the BtB VSCs via a dc cable [27]. The VSR and VSI are two-level converters consisting of six cells; each comprises an insulated-gate-bipolar transistor (IGBT) in parallel with a diode. In the following subsections, the complete modeling and control of the proposed system is provided.

A. Wind Generator

A full-scale wind turbine (FSWT) utilizing a permanent magnet synchronous generator (PMSG) is elected for its low maintenance and low operational cost [2]. The wind turbine model is represented as following,

$$P_m = \frac{1}{2} C_p(\beta, \lambda)\rho\pi R^2 v_{wind}^3, \quad \lambda = \frac{R\omega_r}{v_{wind}} \tag{1}$$

where P" is the mechanical power captured by the wind turbine blades; C' is the rotor coefficient which is a non-linear function of the blade pitch angle (6) and the tip-speed ratio (λ); ρ is the air density; R is the radius of the wind turbine blade; v1234 is the wind speed; and ω is the mechanical speed of the rotor. In this paper, 6 is set to zero in the normal operating conditions to maximize the wind power generation [13]. The PMSG is modeled as following,

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$$\bar{v}_s = R_s\bar{\imath}_s + L_s\frac{d\bar{\imath}_s}{dt} + j\text{Ƥ}\omega_r(\psi + L_s\bar{\imath}_s) \tag{2}$$

$$J\frac{d}{dt}\omega_r + \beta\omega_r = \frac{3}{2}\text{Ƥ}\psi I_{sq} - T_m \tag{3}$$

In (2), $\bar{v}$A and $\bar{\imath}$A are the stator voltage and current in the complex vectors representation, respectively, where a complex vector $\bar{x} = X_d + jX_q$ such that X4 and XN are the direct (d −) and quadrature (q −) components of $\bar{x}$ in the rotating reference frame; RA and LA are the stator-winding resistance and inductance, respectively; j is the imaginary unit number; ψ is the flux linkage of the rotor magnets; Ƥ is the number of poles pairs; T" is the mechanical torque; whereas J and β are the motor inertia, and viscous friction, respectively.

B. Machine-Side Voltage Source Rectifier (VSR)

The VSR is utilized to capture the maximum wind power by regulating the mechanical rotor speed of the PMSG to follow the MPPTw characteristics in Fig. 2, using the PI speed controller (Gs (s)) in (4).

$$I_{sq}^* = (\omega_r^* - \omega_r)\, G_s\,(s)\,,\ I_{sd}^* = 0 \tag{4}$$

The PI speed controller (Gs (s) = gps + gis/s) is implemented in the outer loop, where s represents the differential operator and the superscript "∗" denotes the reference values of the variable. The speed controller regulates the PMSG speed to the optimal value (ω∗ r) and dictates the q- component of stator current reference (I∗ sq), whereas I∗ sd is set to zero to operate at maximum produced torque [19].

$$I_{sq}^* = (\omega_r^* - \omega_r)G_s(s), \quad I_{sd}^* = 0 \tag{4}$$

Where s represents the differential operator. Solving (3) and (4), assuming IAN ≈ IAN ∗ within the bandwidth of the speed controller (GA(s)), and setting g2A⁄g'A = β/J, the closed-loop transfer-function of the speed controller becomes; $\omega_r/\omega_r^* = \left(\frac{3}{2}\mathrm{P}\psi g_{ps}/J\right)/\left(s + \left(\frac{3}{2}\mathrm{P}\psi g_{ps}/J\right)\right)$, where the

Band width is $\frac{3}{2}\mathrm{P}\psi g_{ps}/J$ [rad/s], and is selected to be around 10% of the bandwidth of the inner current controller [discussed in the following paragraph]. The speed controller parameters, i.e., g'A and g2A, can be tuned accordingly. As shown in Fig. 1 and (5), a PI current controller $(G_i(s) = g_{pi} + g_{ii}/s)$ is employed so that the generated stator currents of the PMSG follow the corresponding references in (4).

$$\bar{v}_s = (\bar{\imath}_s^* - \bar{\imath}_s)G_i(s) + j\mathrm{P}\mathring{\omega}_r L_s \bar{\imath}_s +$$

Where $j\mathrm{P}\mathring{\omega}_r L_s \bar{\imath}_s$ is the decoupling loops; H is a gain; whereas the superscript "○" denote the steady-state value of the variable. The current controller in (5) is designed by solving (2) and (5). By setting $g_{ii}/g_{pi} = R_s/L_s$, the closed loop transfer function of the current controller becomes; $I_{sd}/I_{sd}^* = 1/(\tau_i s + 1)$, where the bandwidth of the current controller is $1/\tau_i = g_{pi}/L_s$ [rad/s], and is selected to be around 10-20% of the switching frequency of the VSR. Fig. 1. The proposed wind-PV cogeneration system. Levels.

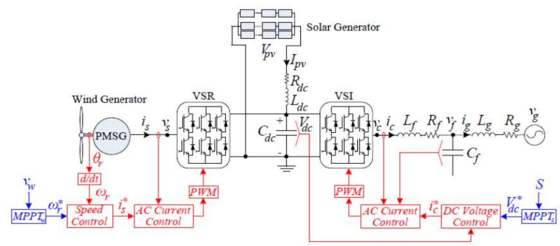


Fig. 1. The proposed wind-PV cogeneration system.

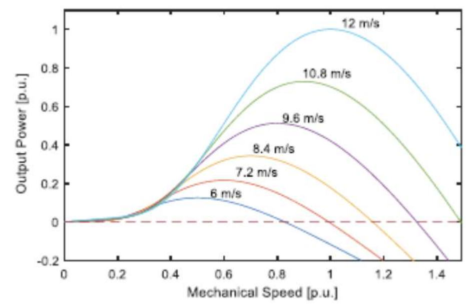
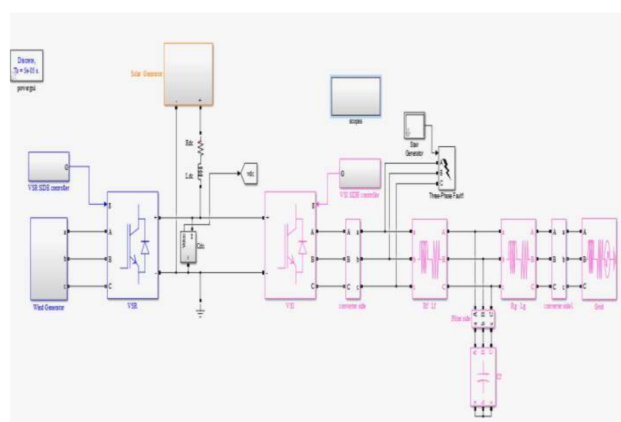


Fig. 2. Mechanical characteristics of the wind turbine at different wind speeds.

Lates the PMSG speed to the optimal value (ω_r^*) and dictates the q- component of stator current reference (I_{sq}^*), whereas I_{sd}^* is set to zero to operate at maximum produced torque [19].

IV.SIMULATION RESULTS:



4.1 Proposed simlink diagram

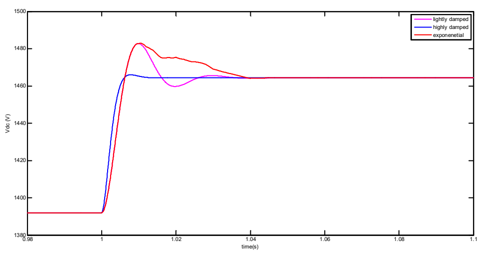


Fig.4.2 The step response of the dc-link voltage to verify the developed small signal model

Wind solar references:

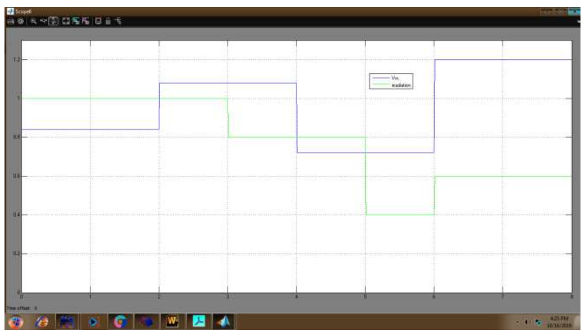
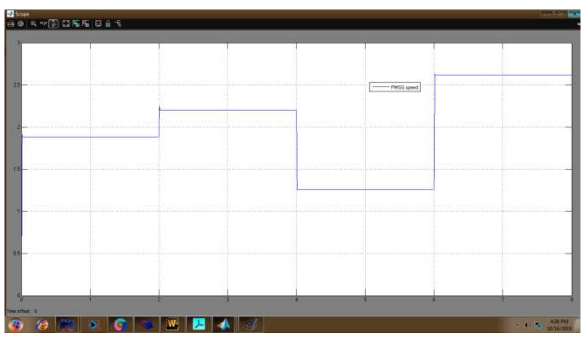
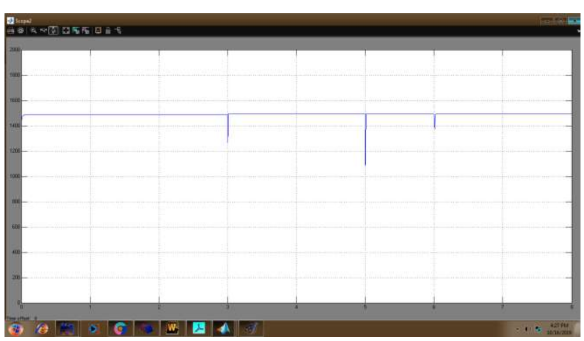
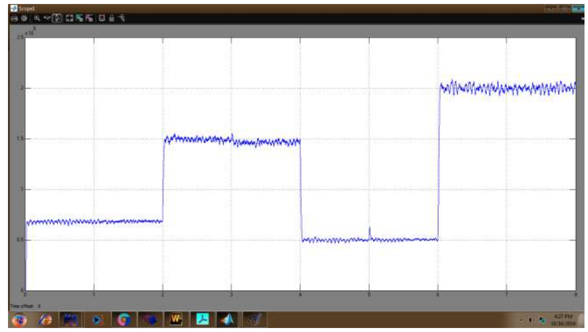
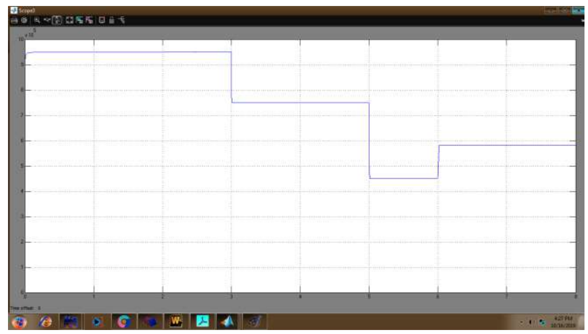


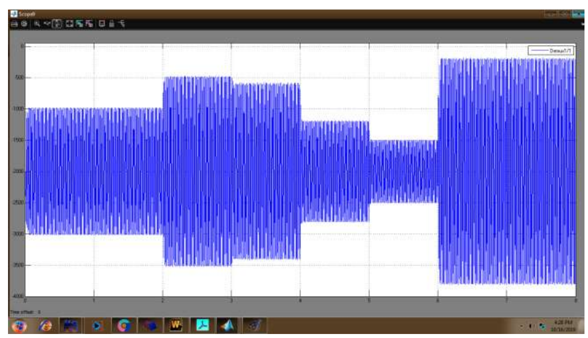
Fig.4.3 Wind and solar both:

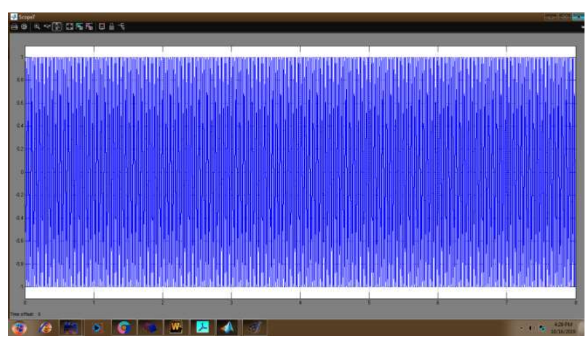


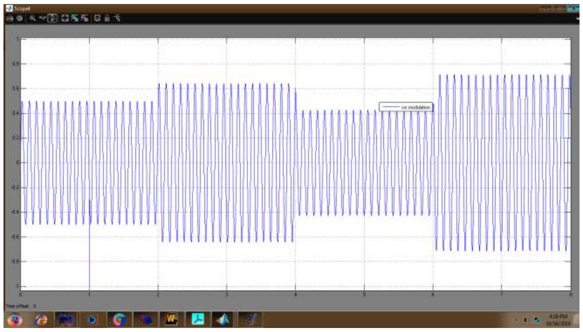












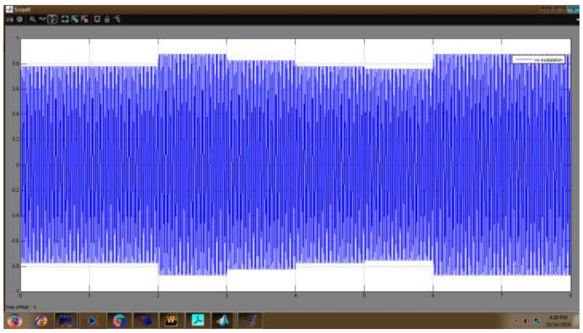


Fig.4.4 Wind only

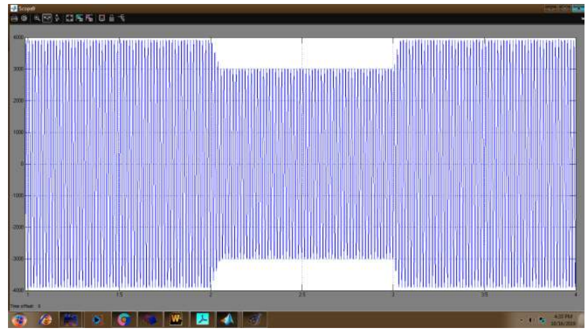
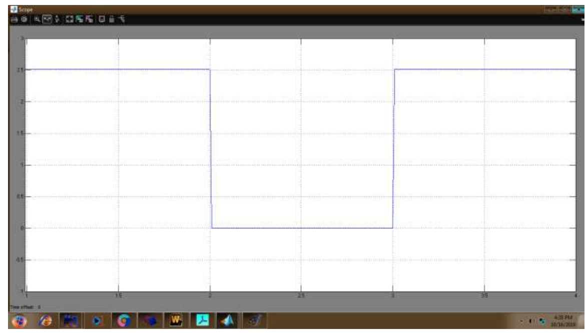
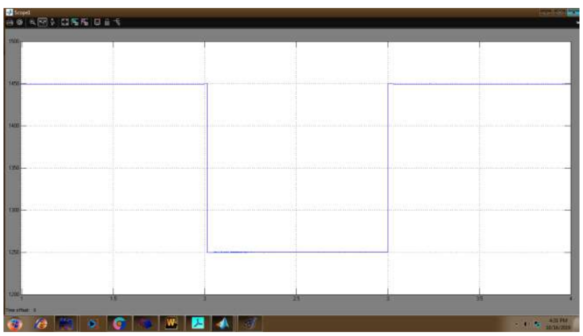
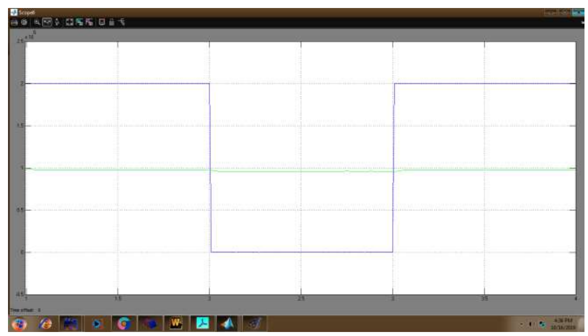
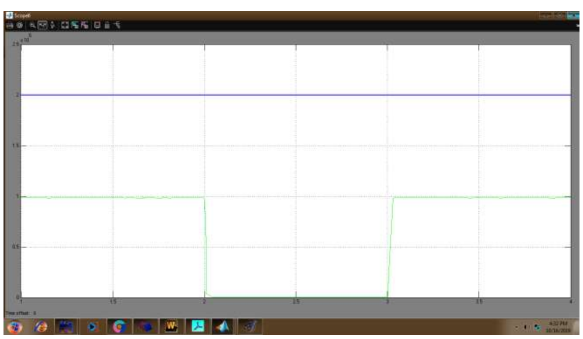


Fig.4.5 Solar only









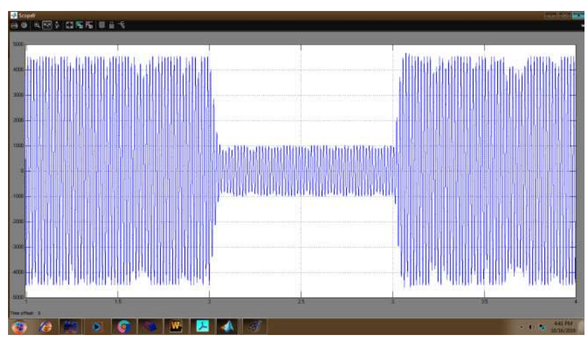
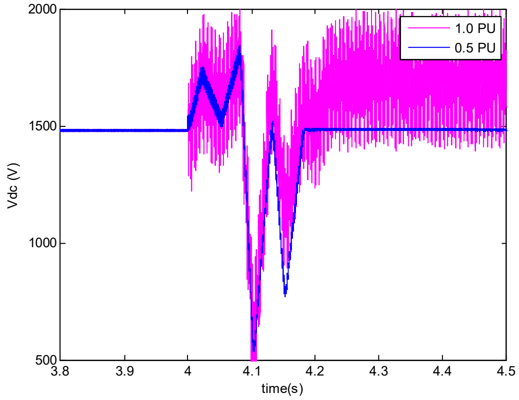
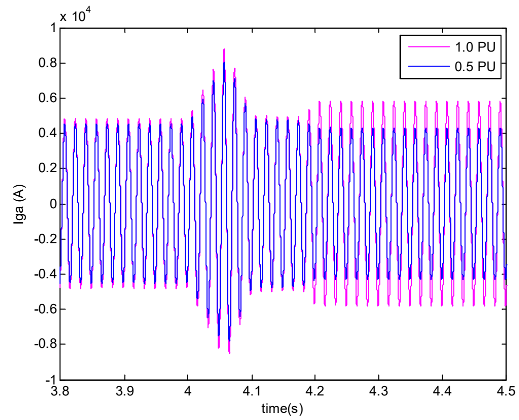
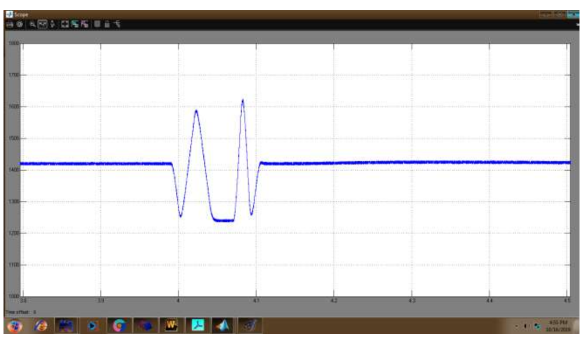
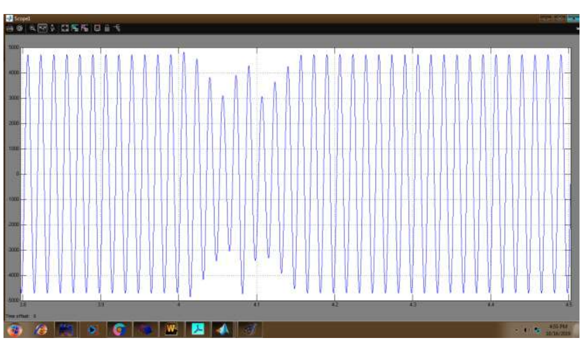


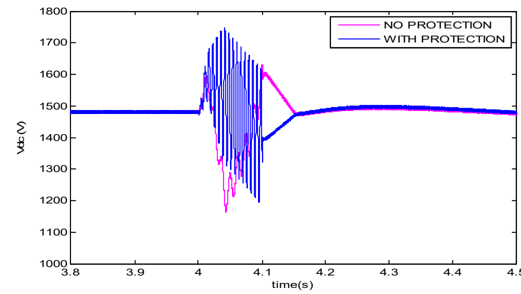
Fig4.6 3phase ground

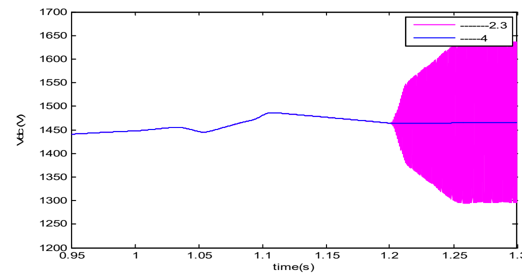


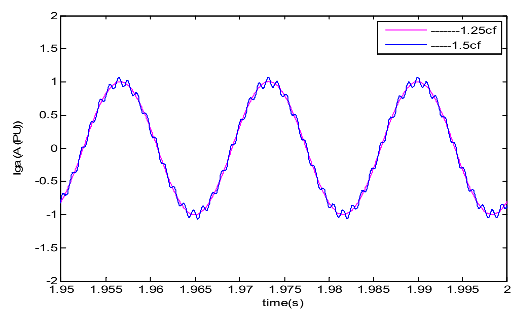












V.CONCLUSION:

This research examines an effective smart grid based on ANFIS regulation to improve electricity quality. Following changes in wind speed, the VSR at the wind generator side is in charge of obtaining the most wind power possible. The VSI's functions on the utility-grid side include maximizing the PV power from the PV generator, balancing the input-output powers across the dc-link capacitor, and maintaining a constant PCC voltage across various operating modes. The suggested ANFIS control-based method improves power quality while suppressing the network's failure tolerance.

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