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POWER QUALITY IMPROVEMENT IN HYBRID POWER SYSTEM USING D-STATCOM

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ABSTRACT

The use of distributed energy sources in power grids has created new demands on payloads, as associated power quality, voltage regulation and economical use of energy. The wind and star squares are the most encouraging sources of renewable energy. However, stand-alone operation of photovoltaic or wind energy systems does not provide a particularly reliable supply of power generation, mainly because the supply of wind and solar radiation is unpredictable. The selection of relevant wind and alternative power generation structures therefore offers a great wealth of possibilities and a reliable power supply. As part of this work, a hybrid model of wind and solar power systems was presented. This type of system is useful in remote or island areas where grid integration is not very economical. However, connecting power electronic devices to a system of metric weight units presents serious power quality issues: B. Harmonic generation and reactive power compensation that disturbs the facility's electrical distribution system. During this work, a simulation model of a hybrid wind-solar power system with an output of 750 kW was awarded. We analyze the performance of this method in grid join mode. The turbine quality of a wind SPV hybrid system was evaluated using total harmonic distortion (THD) at completely different wind speeds. The power quality of this hybrid system was improved by manipulating the D-STATCOM.

Key words: FACTS, THD, power quality, D-STATCOM

I. INTRODUCTION

With the recent intensification of environmental problems caused by shadow fuels, using your own energy sources to generate electricity is only a potential alternative to fossil fuels. Renewables such as solar and air currents Energy sources are expensive to obtain. These two are considered the most important sources of renewable energy. Conversely, the main obstacle for each light and airflow is the inability to individually provide constant radiation or constant velocity airflow. Therefore, it cannot be used as a stand-alone that requires continuous power supply. The integration of different energy sources with energy storage systems is an entirely new trend in renewable energy technology. Among the various hybrid combinations, independent wind and electric star phenomena are the most effective hybrid combinations. Wind SPV hybrid power generation systems (WSPVHG) combined with grid integration are considered power generation options as they exploit the strengths of each star and wind energy system [2]. Hybrid systems can provide reasonable power quality and reduce electricity bills at the same time. Apart from all the advantages, hybrid systems have their own challenges and issues such as protection, synchronization and power quality, but we tend to discuss only power quality here. Performance criteria are measured by voltage drop, harmonics and power issues. This work tends to calculate harmonics to check the quality of plants with hybrid wind power systems.

FACTS

A flexible alternating current transmission system (FACTS) is a system of fixed equipment used to transmit electrical energy using alternating current (AC). Its goal is to increase network control and power transfer capability. It is, in general, a power electronics-based system. FACTS is defined by the Institute of Electrical and Electronics Engineers (IEEE) as "a power electronic-based system and related static equipment that controls one or more AC transmission system parameters to improve controllability and boost power transfer capability." FACTS Improve AC grid reliability and reduce power delivery costs "in accordance with Siemens They improve the quality and efficiency of energy transmission by supplying inductive or reactive power to the grid.

II. HYBRID WIND-PHOTOVOLTAIC SYSTEM

Get an overview of hybrid renewable energy systems. This is because two or more generating sources must be installed to generate the electrical load in the system. Hybrid power generation systems that combine wind power and grid integration may be an alternative to power generation as they leverage the strengths of each star and each wind turbine [3]. To meet increasing load demands, this combination can provide the simplest resolution in standalone or grid-connected mode. Grid-connected mode not only reduces value, but also improves system reliability and performance. The grid draws its own energy from the hybrid wind power system during sunny and cloudy days to supply the connected loads. Reduced peak load, reduced line loss, remote deployment and most importantly reliable installation are the major subsequent benefits of HRES [10].

A. SPV System Modeling

The photovoltaic (SPV) cell is the basic part of the PV system. SPV cells are not connected in parallel to create an SPV module, so the combined SPV modules form an SPV array [1]. Figure 1 shows an approximate circuit of an SPV cell.

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Generally, the formula to model a complete SPV cell is given by:

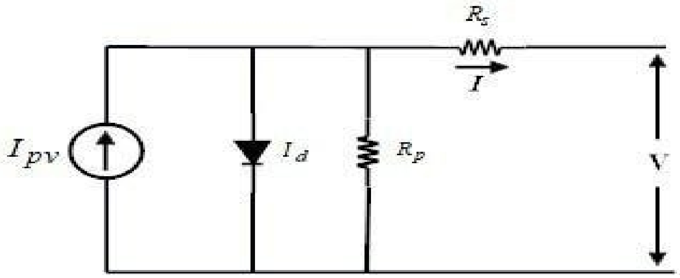

Fig-1 Approximate equivalent circuit of a Solar Photo Voltaic cell

$$I = I_{pv} - I_0 \left(e^{\frac{qV}{akT}} - 1\right) \quad (1)$$

$$V = V_d - IR_S \quad (2)$$

Where V is the stellar radiation current, Io is the diode leakage current, the letter is the negatron charge, k is the Boltzmann constant, T is the junction temperature (oK), and Vdis is the voltage across the diode. If connected to some extent, the problem is the quality of the diode. Figure 2 shows a Simulink model of a PV cell created by the given equations.

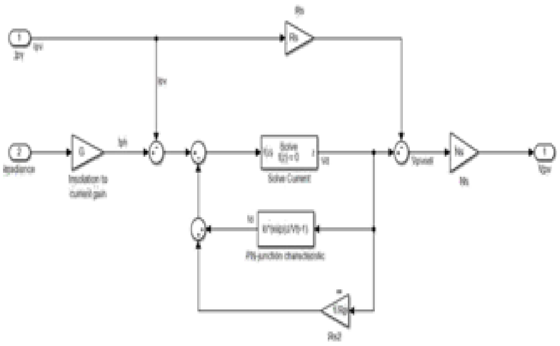

Fig-2 SIMULINK Model of SPV Cell

B. Modeling of WECS

The quantity of turbine power produced by wind turbine generator (3)

$$P_i = 0.5 * \ell * C_p * A_s * V^3 \quad (3)$$

Where Pi is the power generated by the WTG, As is the area swept by the wind in square metres, V is the wind speed in metres per second, and Cp is the performance constant. The performance constant is determined by the quantitative relationship of tip speed to wind speed, also known as the tip speed quantitative relationship [4].

Figure 3 depicts the Simulink model of a static magnet synchronous generator (PMSG)-based WECS.

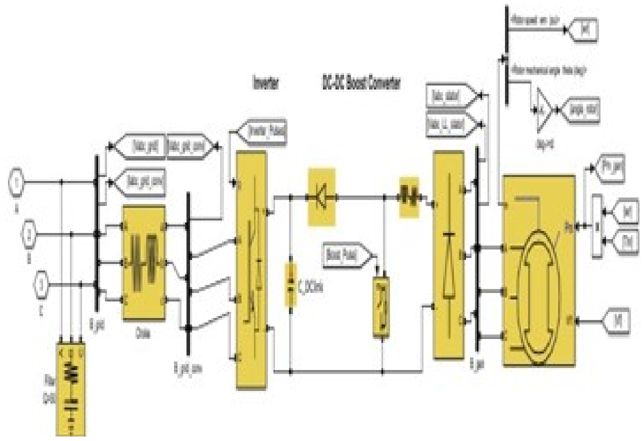

Fig-3 SIMULINK model of Wind turbine generator

III. D- STATCOM MODELLING

Since wattage systems are primarily concerned with AC magnitude and most masses used require reactive power, reactive power compensation can be a governmental quality issue [7]. Reactive power flow must be controlled to generate the required voltage support for WECS voltage fluctuations [5].

During voltage dips, the STATCOM has a greater advantage for generating additional electrical phenomenon reactive power.

A. STATCOM

A natural philosophy operating device capable of receiving or absorbing reactive power at its output terminals. When connected to a battery storage device, it can handle an additional $64,000 of energy[12]. Unlike SVCs, no costly inductive and electrophysical components are required to add reactive power support to transmission lines [8]. The main advantage of the STATCOM area unit is the less installation space required due to its compact size and increased reactive power efficiency at low voltages. STATCOMs also impart greater damping properties for dynamic read stability [6].

The synchronous static compensator (STATCOM), also known as a synchronous static capacitor (STATCON), is sometimes a control device used in transmission networks. It is supported by a natural voltage source converter and can act as a source or sink of AC reactive power in the associated power grid. When connected to a power source, it can also supply active AC power. It is a member of the FACTS family of devices. This is standard in nature and optional.

The STATCOM can be a Voltage Supply Converter (VSC) based device with power behind the inductor. A STATCOM has very little available power capability because power is supplied by a DC electrical device. However, its active performance increases if an acceptable energy storage device is connected across his DC electrical device. The reactive power at the terminals of the STATCOM depends on the amplitude of the power supply. For example, if the terminal voltage of VSC is higher than the AC voltage for membership purposes, the STATCOM will generate a reactive current. Conversely, it absorbs reactive power as soon as the amplitude of the source becomes less than the AC voltage. The STATCOM's response time is faster than that of the static voltage-current compensator (SVC), mainly due to the fast switching time provided by the power converter IGBT. Because the reactive power from the STATCOM decreases linearly with AC voltage, the STATCOM simultaneously provides higher reactive power support at low AC voltages than the Associate in Nursing SVC (currently held at nominal value down to low AC voltages because there are many things).

This document used D-STATCOM to enhance asset quality in hybrid microgrids. A D-STATCOM connected for common coupling (PCC) is often used to mitigate both voltage and related power quality issues. To generate a balanced and pure curve of supply current, the D-STATCOM injects harmonic and reactive parts of the load current when operating in current management mode. To protect the vital mass from large voltage disturbances, the PCC voltage was the reference value controlled in voltage management mode [9].

The STATCOM can be a regulated reactive power supply. It provides the required reactive power generation and absorption through the electronic process of voltage and current waveforms in Voltage Source Converters (VSCs).

A single-wire STATCOM circuit is shown in Figure 4(a). Here VSC is connected to the power bus by magnetic coupling.

• In the figure 4 (b) STATCOMs are viewed as adjustable voltage supplies behind electrical phenomena. This means that electrical capacitor banks and shunt reactors are not required for reactive power generation and absorption, giving the STATCOM a compact style, or a small footprint as well as a small noise. Low magnetic effect. The exchange of reactive power between the

•converter and the AC system is often controlled by varying the amplitude of her three-phase output voltage Es of the converter, as shown in Fig. 4 (c).

• When the amplitude of the output voltage increases to the amplitude of the supply bus voltage Et, the electrical phenomenon causes current to flow from the converter into the AC system, causing the converter to generate capacitive reactive power in the AC system.

If the output voltage amplitude is lowered below the utility bus voltage, current flows from the electrical energy system to the device, absorbing inductive-reactive power from the electrical energy system.

• STATCOM conceptual diagram:

a power circuit; b a constant circuit; and c a control exchange circuit

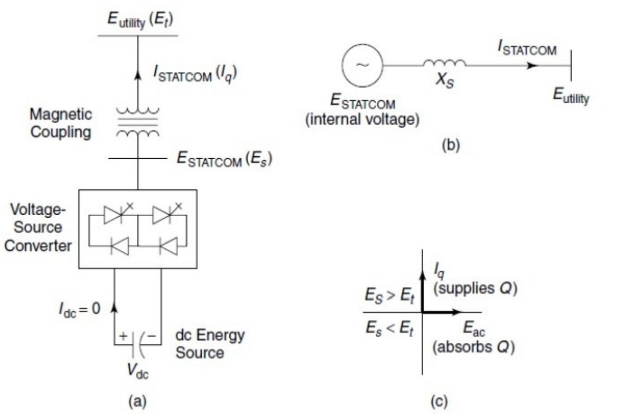

Fig. 4 STATCOM schematic:

- (a) Sphere of influence. (b) a similar circuit; (c) Influence Exchange STATCOM shall be in a highly pending state.
- • Active power exchange between the converter and

the AC system is evenly managed by adjusting the fractional shift between the converter's output voltage and the AC system's voltage. In other words, if the converter output voltage is shaped to lead the AC system voltage, the converter provides active power from DC storage to the AC system.

IV. PROPOSED SYSTEM MODEL

In this document, the transport is developed considering the combination of an SPV farm with a generating capacity of 250 units and a WT with a capacity of 500 units to create a WSPVHG system with a total capacity of 750 units. This hybrid system is integrated into the 120 kV grid via a 25 kV distribution system. Figure 4 shows the determined diagram of the predicted hybrid power generation system with distributed electrical converters. Within the planned structure, each wind and SPV system was suitably assembled as two separate generating systems with individual electrical DC-AC converters and connected in parallel at the output side of the electrical converters [11].

A 25 kV, 3 Mvar, D-STATCOM is connected for common coupling purposes. A projected shunt controller must source or absorb reactive power to ensure voltage stability throughout the system.

Green power is initially referred to as fuel supply derived entirely from sunlight-based energy, either directly or otherwise. However, broadly speaking, much of the energy we tend to consume today, along with petroleum products, is considered a form of solar-oriented energy. Most familiar forms of energy such as wood, oil, gas, and coal are embodied forms of solar energy that are collected, removed, and converted through common cycles. Environmental change due to emissions of greenhouse gases, especially carbon dioxide, becomes a problem when energy from the sun is converted into usable forms of energy (heat, electricity, fuels, plastics) at a rate that far exceeds the rate of development. . For coal, oil and gas, the ratio of development to consumption hours is about 1 million to 1:

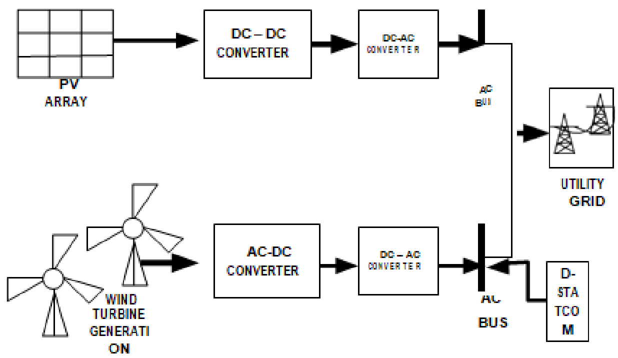

Fig-5 Schematic diagram of proposed hybrid system with DSTATCOM

. So the Earth, in a characteristic cycle, consumes in one year what it took her 1,000,000 years to create. Simple biomass beneath these distant structures accounts for a fraction of a few years or less. Green power can now be described as a type of solar energy that is available and rechargeable over timescales longer than human life.

Given that energy is green, it's clear why your own energy can be an important alternative for mitigating

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Vol 19, Issue 3, 2025

environmental change. Because green energy is of little use if gas-decomposing substances are released, its use does not disturb the radiant energy balance of the world's air and can provide reparative long-term environmental mitigation. . Green forces allow environmental change, energy use, and financial progress to continue together rather than against each other. The remainder of this section may indicate which information, information, and logical devices are intended to identify, explore, and describe green energy alternatives. Required information and knowledge includes:

$ financial and social improvement goals and desires energy use and tasks to be performed attributes of energy needs energy needs (span, irregularity, time of day, etc.) $ Available Energy Assets and Innovation Mapping Once energy needs are identified within the larger framework of financial and social progress aspirations and plans, identify and integrate green energy assets and progress into that larger framework. can be evaluated for The logical tools needed include methodical methods for stockpiling green energy assets and, most importantly, assessing the correct use of these assets. This section provides a top-level view of real estate energy selection and explores, analyzes, and presents green energy improvements. Techniques for decomposing green power determinations within the Associate in Nursing include system squared measurements as described in Chapter 3. Strategic choices for enhancing property performance progress choices are briefly presented towards the end of this half.

A. Choice of Mitigation Technologies

Sustainable energy supply involves a wide range of assets, and various advancements are available to take advantage of these assets. Today, numerous innovations and associated spoken languages describe each innovation and its application. A significant amount of these advancements have been addressed to date, most of which have entered the global business market at some level. Some have achieved market entry, such as hydropower and biomass innovations, others (eg) 4.1.3. Primarily daylight-based energy

Solar-based advancements use the sun's energy directly as energy commonly used in all three of these end uses, providing energy to mechanical cycles, structures, and transportation. Given primarily the positive scale of Solar Base, these advances are not being forced by commodity conditions, but by price and other factors such as execution (e.g. erratic activity), sawing risk, and seating issues. Forced by "institutional" incentives. There are two general classifications of PV devices.

level plate and focusing. A concentrator system uses a focal point to focus the radiation onto a few high-yield PV cells, using only direct sunlight from the pillars. Flat panels, on the other hand, not only use all the vapor-driven radiation of the incident sun, but also diffuse (scattering) and direct electrical phenomena (PV) - devices use panels made up of various PV cells to converts the energy contained in directly into electricity. There are two general classifications of PV devices:
flat plate and focusing. Concentrator frameworks use a focal point to concentrate the radiation onto just a few highly productive PV cells and use only direct, columnar light, whereas flat panels use diffuse and it uses all radiation the sun produces, including direct protection.

IV. RESULT AND ANALYSIS

The MATLAB FFT (Fast Fourier Transform) Analysis Toolbox is used to determine the THD. To examine the quality of the electricity supplied by the proposed arrangement, the THD in the current sent to the grid was determined. THD was calculated without and with D-STATCOM at a wind speed of 5m/s for comparison purposes.

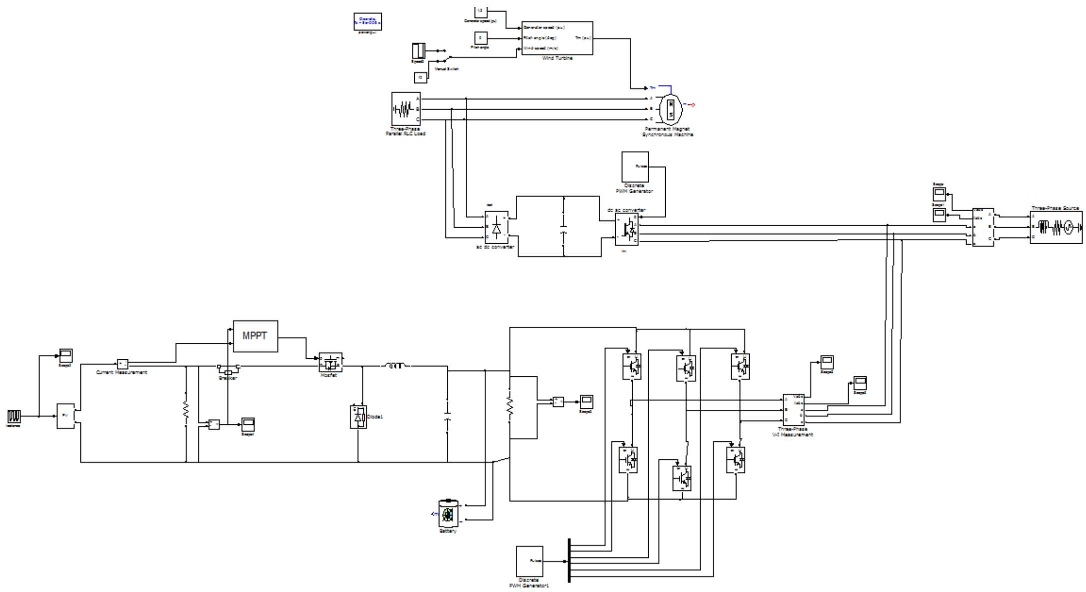

Fig. 6 p-v-wind without D-statcom

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Vol 19, Issue 3, 2025

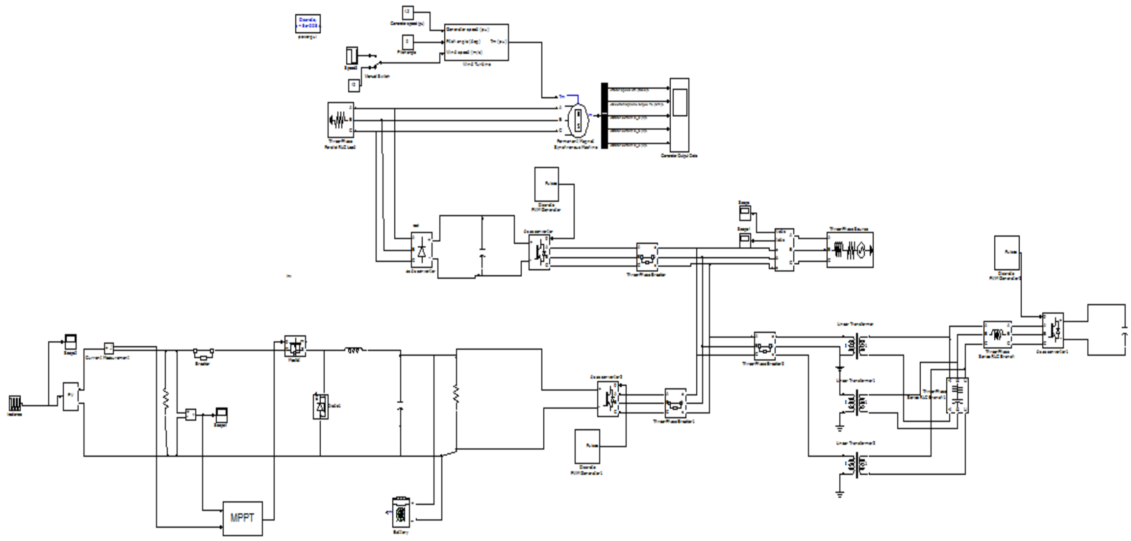
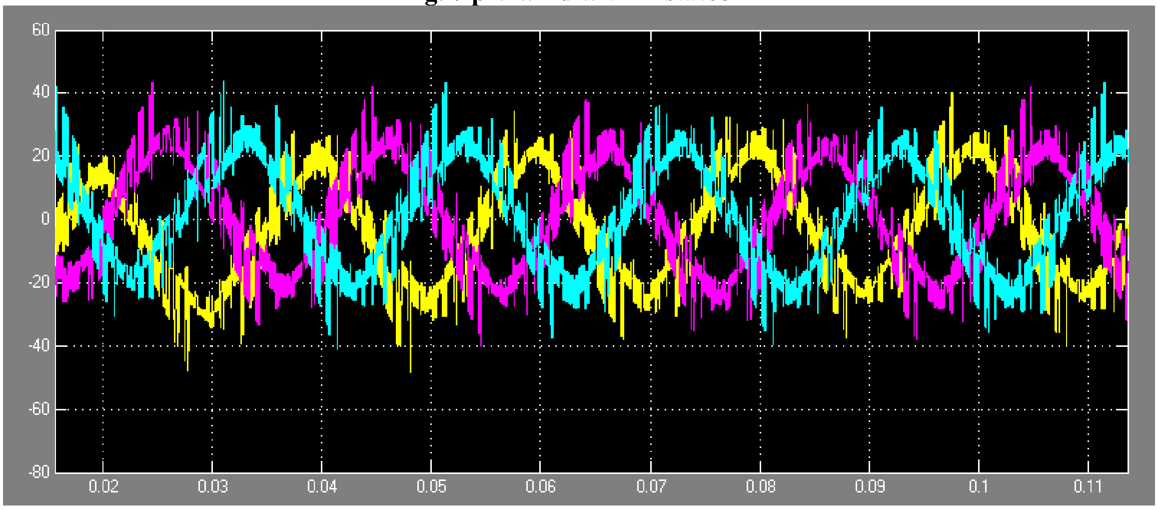
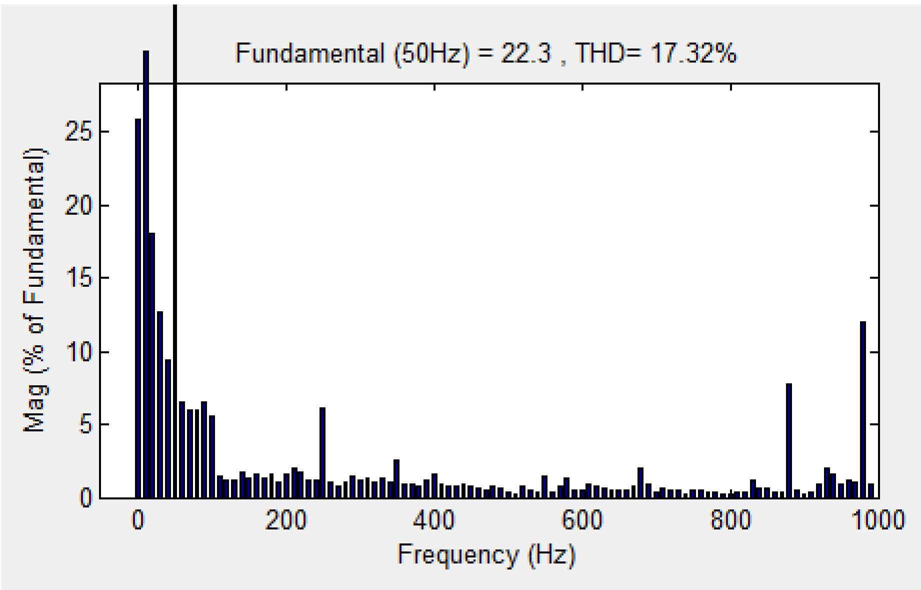


Fig. 7 p-v-wind with D-statcom



(a)



(b)

Fig-8 THD of the current supplied by the PV system without D-STATCOM

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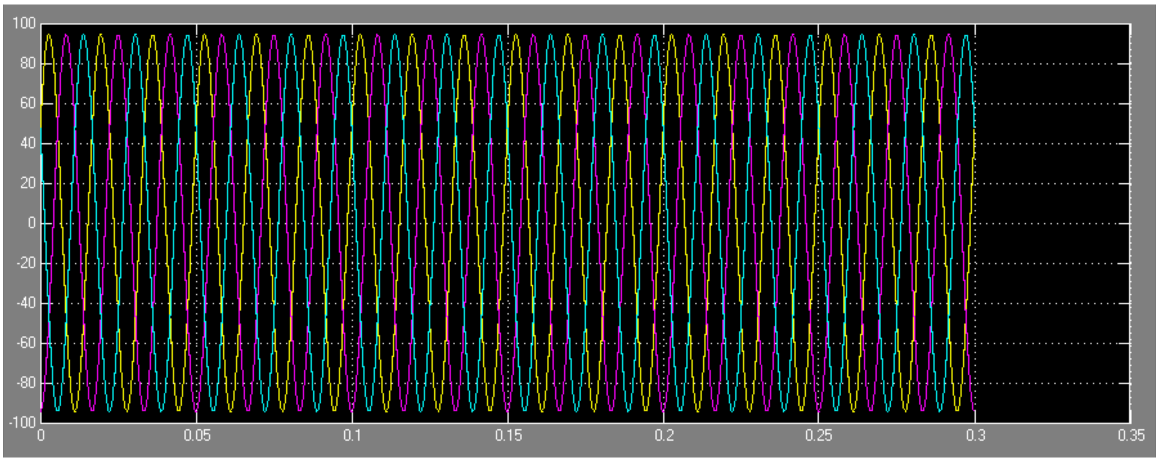
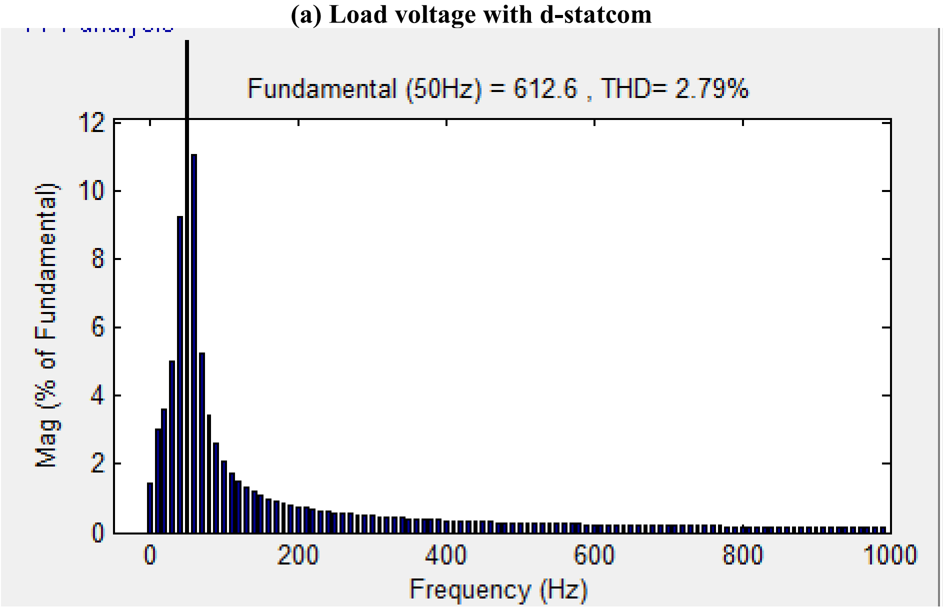
Vol 19, Issue 3, 2025

THD of the hybrid Wind-PV system's current delivered at 5m/s wind speed without D -STATCOM

The THD of the provided current at 5 m/s wind speed without connecting D-STATCOM is 15.4%, which is rather high and even above the IEEE limit. According to IEEE power quality requirements, THD must be less than 5%. Thus, in this study, D- STATCOM is used to bring the total harmonic content within the IEEE requirements by utilising compensatory techniques.



(a) Load voltage with d-statcom



(b)

Fig. 9 THD in current delivered by a hybrid Wind-PV system at a wind speed of 5 m/s using D -STATCOM

Figures 8 and 9 compare total harmonics distortion with and without D- STATCOM in each scenario. The THD in the current supplied by the hybrid wind-PV system is decreased to 2.74% using D-STATCOM, which is a better result than the other. This indicates that the adoption of D- STATCOM has enhanced the power quality. According to IEEE standards, the suggested wind-PV hybrid system's power quality is presently quite adequate.

V. CONCLUSION

The goal of improving the power quality of the suggested hybrid PV-wind system was met in this work. Figure 6 depicts the enhanced THD observed by FFT analysis in the presence of D-STATCOM. The D-STATCOM is used to simulate a hybrid power system. The result reveals that the total harmonic distortion (THD) is less than the IEEE standard of 5%. This implies that the suggested wind-PV hybrid generation model is working properly.

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