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"ANALYSIS OF HYBRID SOLAR WIND ENERGY SYSTEM USING MULTI OBJECTIVE CONTROL FOR CONVERTER"

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ABSTRACT

Grid-tied photovoltaic systems are power-generating systems that are connected with grids in this study are designing of a grid integrated solar wind hybrid energy system for driving loads for improving its reliability and efficiency. Designing an inverter control that attains lower distortion level in the voltage as well as current waveforms. The controller should reduce the spikes at the transient loading point when the system is subjected to sudden load changes. And the system is to be integrated with the fuel system also to obtain the energy efficiency. The fuel system would be connected in parallel to the DC voltage output of the solar/wind hybrid system. Improvement in the reactive power output from the system by the inverter control by designed hybrid system that can compensate the reactive power requirement when required. This project should attain the hybrid solar/wind/fuel system with proposed controller to improve the output parameters. The final hybrid system with fuel cell integration was studied for the total harmonic distortion in the voltage and current waveform. The distortion level in the voltage waveform was found to be 0.39% and that in the current waveform was 1.95%. It is under the IEEE acceptable limits.

Keyword: *Grid system, Solar System, hybrid system, DC, PV.*

I. INTRODUCTION

Wind solar hybrid companies use a variety of alternative energy sources, such as solar and wind power, to generate electricity. Photovoltaic cells and vertical axis wind turbine generator are used to generate electricity in this setup.

To comprehend the operation of a solar radiation hybrid power system, we must first comprehend the operation of a solar panel system and a wind energy system. A roof top solar systems are systems that harnesses sun energy to generate electricity using photovoltaic power. The graphic depicts a block schematic of a solar radiation hybrid power system with solar panels and a wind generator for generating electricity.

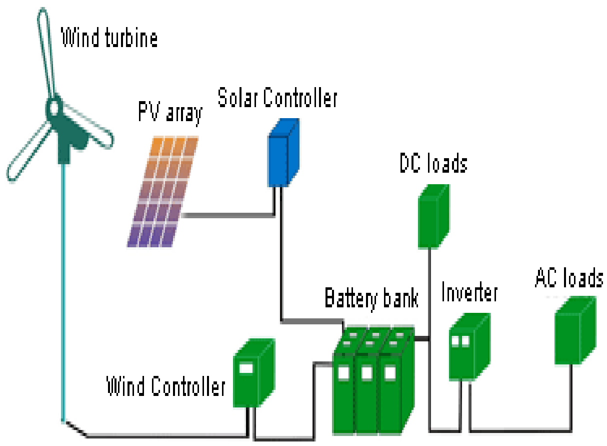

Fig. 1 Hybrid Energy System

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Wind energy is another clean energy source that may be used to generate electricity through the use of wind farms and generators.

A wind turbine is a fan with two or three blade that revolve in response to wind, and the pivot point must always be oriented with the direction of flow. A steering system is an elevated machine element that is used to efficiently convert from one gadget to another through conventional technology. Wind turbines come in a variety of shapes and sizes, but the most common are horizontal and rotational symmetry windmills.

Solar power systems are made up of three main components: solar panels, photovoltaic power modules, and power storage battery. The excess electricity (DC power) produced by solar panels can indeed be stored in the battery, used to provide Capacitor banks, and then used to feed AC loads using a converter. Renewable radiation is only accessible across the day, however offshore wind is constantly available of the day, depending on the season.

Because wind and sun energy complemented one another and, the system can generate energy virtually all year round. Wind aero generator and tower, solar photovoltaic panel, battery, connections, voltage regulator, and inverter are the critical elements of the Winds Sunshine Hybrid Energy system. The Wind-Solar Hybrid System creates energy that may be used to recharge the battery and run AC appliances via a converter. The windy aero-generator is mounted on a tower that is at least 18 meters above ground level. The aviation provides greater power and for its height, which allows it to catch the wind at a quicker pace.

An piece of technology that transforms direct current (DC) voltage to alternating current (AC) voltage and may run concurrently with the power system is known as a transmission line or grid tie inverter (GTI). Photovoltaic systems or power storage devices are commonly used to generate DC voltage. GTIs allow photovoltaic systems to be connected to the grid. The power conditioning circuits in a GTI work in a similar way to those in a traditional stand-alone DC-AC SMPS. Their control algorithms and safety features are the most significant distinctions. A GTI converts variable uncontrolled voltages from such a rooftop solar array to AC that is synced only with distribution system. When the grid goes down, it should instantly stop sending energy to the power lines. A GTI can power your home and potentially feed extra electricity back into the grid to help you save money on your electricity costs.

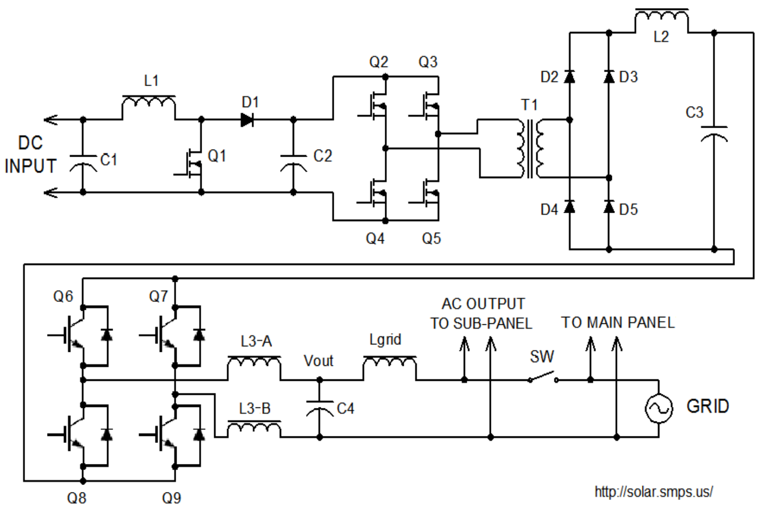

Fig.2 Grid Tie Inverter (GTI)

GTIs circuits typically contain one to three phases, dependent on power and incoming voltage levels. The fundamentals of functioning of a 3-grid tie converter are illustrated in the schematics picture below. Reduced input (such as 12V) in grounding circuits can benefit from this layout.

The boost converter, which consists of inductor L1, MOSFET Q1, diode D1, and capacitor C2, raises the voltage source first. According to the National Electric Code®, if a PV array is rated for greater than 50V, one of the input

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electric power buses must be grounded. The NEC®, on the other hand, provides for several exclusions, which we will describe further below. Although either of two buses can theoretically be attached to the earth, it is generally the negatives one. It's necessary to keep in mind that in distribution networks, if the DC input has a conductivity passage to grounding, theoutput AC conductor should be insulated from the DC.

II. Method

Individual elements effectiveness is modeled using either predictor - corrector methods. The basic mathematical components of a photovoltaic, as well as the modeling of conversion controllers, are provided in this chapter.

Boost converter Designing-The Voltage Source inverter block shows a conversion that boosts DC voltage using a microprocessor and entrance generation connected to it. Because they enhance output voltages, boost conversions are indeed known as step-up power systems. The Boost Converter block lets you construct an asynchronously conversion with one shifting devices or a synchronously conversion with two semiconductor switches, such as a GTO (Gate turn-off Thyristor), IGBT, MOSFET or Thyristors.

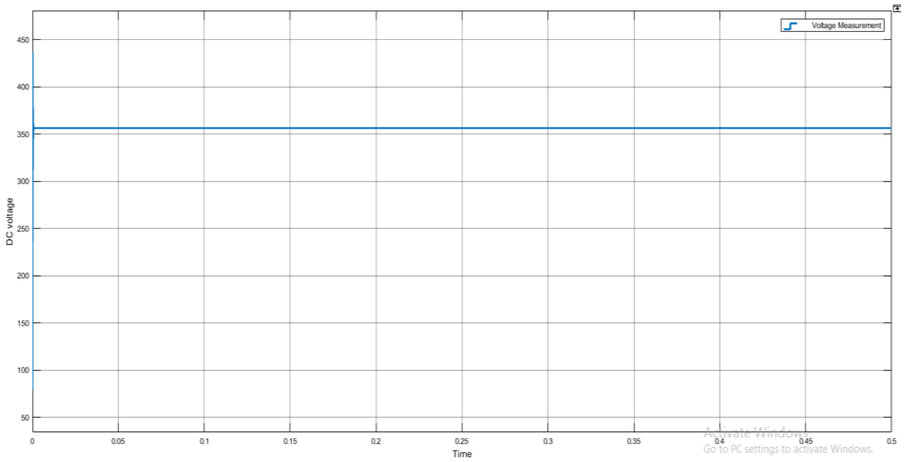

Fig.3 DC voltage waveform after the boostconverter

The Boost Converter block lets you construct an asynchronously conversion including one changing gadget or a synchronously converters with two semiconductor switches, such as a GTO (Gate turn-off Thyristor), IGBT, MOSFET, or Thyristors. In our research, we used a charge controller to regulate and stabilize the DC link voltage over time. The DC output current from the device after employing the DC-DC charge controller is shown in the diagram. It was discovered that following boost conversions, it increased to around 390 volts. Using a met heuristic technique for process improvement controllers, this enhances the input power to the converter for DC/AC conversions.

PV Module modelling

PV systems classified as expressed in a formally and power system Stand-alone and efficiency or energy photovoltaic cells are the two types of photovoltaic panels. PV systems are classified according to their operational and strategic needs, constituent combinations, and connections to other load demand and forms of energy. Photovoltaic systems can either run independently or in conjunction with both the utility grid. They can be interconnected to energy storage devices and other renewable technologies, and they can provide AC and/or DC power. Grid-connected Photovoltaic systems, as already said, are built to operate in simultaneously and be attached to the electric power grid.

The major component of energy Photovoltaic system is the power conditioning unit (PCU), also known as an inverter, which directly convert the DC power produced by the Solar into AC power that meets the current and frequency performance standards of the transmission network, either for straightforward use on equipment or for sending to the transmission network to earn feed-in tariff recompense. The PCU immediately ceases sending electricity to the grid whenever the network is not powered.

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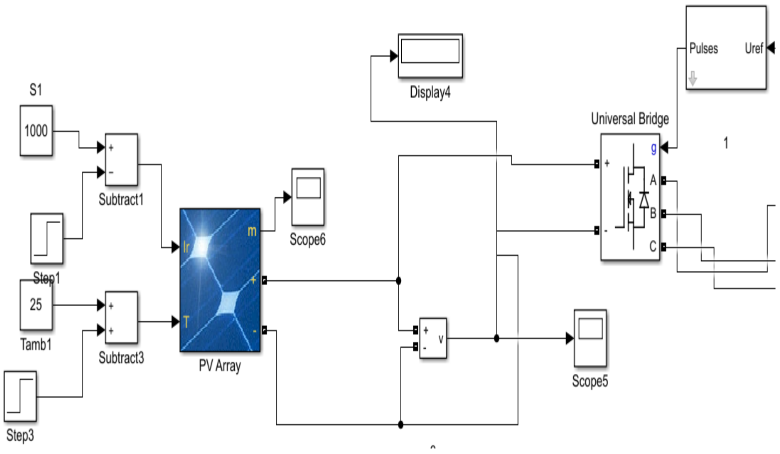

Fig.4 Modeled solar system

A concurrent mixture of cell photocurrent (Iph), exponential diode (D), and shunt resistance (Rsh) is arranged in series with such a cell series resistance (Rs), where I pv and Vpv are really the cells output current, including both. It can be stated as follows:

$$I_{pv} = I_{ph} - I_s\left(e^{q(V_{pv}+I_{pv}*R_s)/nKT} - 1\right) - (V_{pv} + I_{pv} * R_s)/R_{sh} \qquad \text{Eq (3.2.1)}$$

Where:

I ph - Solar-induced current

Is - Diode saturation current

Q - Electron charge (l.6e-l9C)

K - Boltzmann constant (l.38e-23J/K)

n - Ideality factor (l~2)

T - Temperature 0K

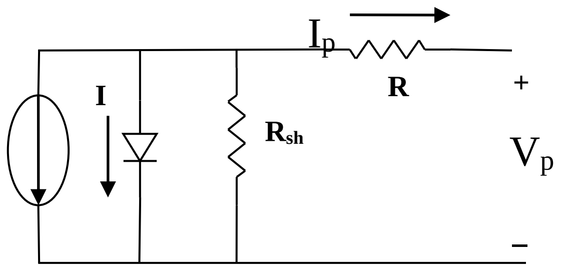

Fig.5 Equivalent circuit of solar PV cell

The solar PV cell's photovoltaic electromotive force is proportional to the solar irradiance and the operating temperature, and could be demonstrated as:

$$I_{ph} = I_{sc} - k_i(T_c - T_r) * \frac{I_r}{1000} \qquad \text{Eq (3.2.2)}$$

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Where:

*Isc*Short-circuit current of cell at STC

Ki Cell short-circuit current/temperature coefficient(A/K)

Ir Irradiance in w/m 2

Tc ,*Tr* Cell working and reference temperature at STC

As shown in Fig. 4.4, a PV cell has an exponentially connection between voltages and currents, with the maximum power point (MPP) occurring at the knees of the curves.

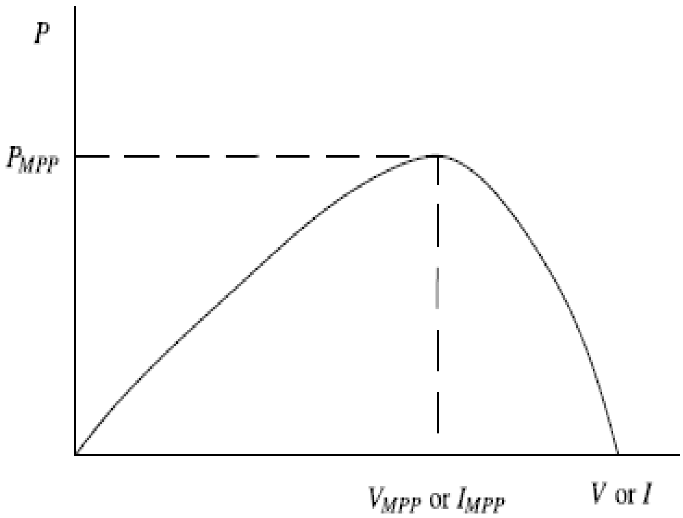

Fig.6 Characteristic PV array power curve

Model	1Soltech 1STH
Maximum Power	213.5 Watts
Number of parallel strings	40
Number series modules	10
Open circuit voltage	36.3 Volts
Shot circuit current	7.84 Ampere
Irradiation	1000 wb/m^2

Proposed inverter modeling and controlling algorithm T

The three - phase power grid linked three leg IGBTs powered converter technology presented in this study is extensively utilized in decentralized generating interfaces. The inverter was controlled by an officially endorsed Conventional pi controller.

DC-AC converters are required whenever the power generation is sent to the grid or utilized by AC loads (inverters). The output of inverters might be single phase or three phase. The industrial plant converter technology, the multilevel inverter framework, the number of co converter framework, and the micro grid inverter (AC modules) framework are the four most typical grid connected inverter for solar power systems.

The previous technique, the central air conditioning inverter, was controlled by a centralized inverters that connected a large generated from Pv panels to the grid. Photovoltaic cells are linked in a series (called a string). To achieve high power levels, these threads are interconnected with thread diode. The technological development is string converters,

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which are a smaller version of the central air conditioning inverter with each strand attached to the converter. Multi-string inverters feature multiple strings that are connected to a central DC-AC inverter via their own DC-DC converter. Because of their own independent maneuverability, power supplies are preferable to industrial plant multilevel inverter. Figure 3.8 shows a three-phase grid-connected DC-AC inverter graphical representation.

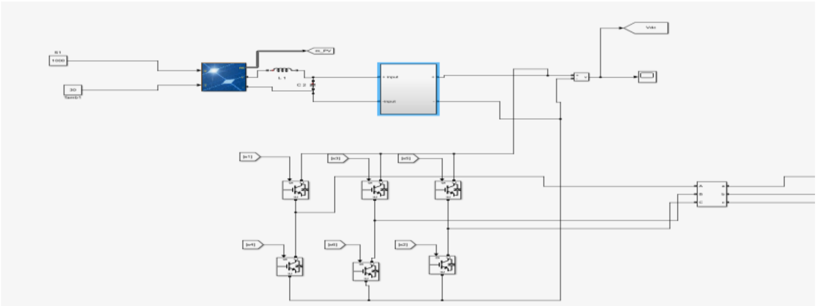

Fig.7 MATLAB/SIMULINK designing of three phase converter

Multilevel Inverter

The multilevel inverter design was made with the goal of improving system configuration. To make studying the elemental pieces and their modifications easier, the design was done in the dq0 stationary frame. The system monitors the changeable variables on a regular basis and changes them as needed.

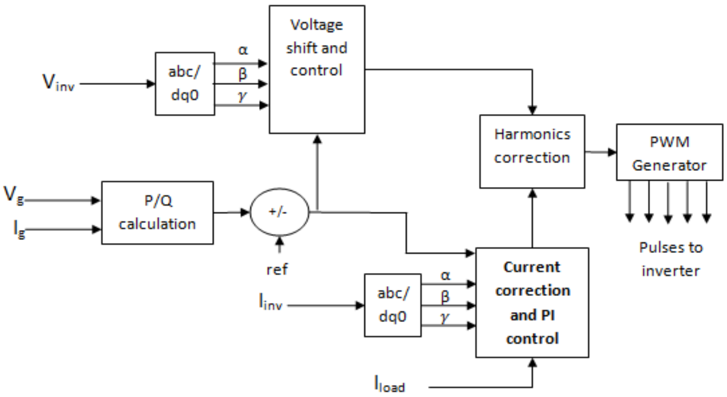

Fig.8 multi objective adaptive constraints approach for quality enhancement controller.

The converter, which is a three-leg, six-pulse inverter, receives pulses from the microcontroller below. Grid characteristics, load specifications, and inverters expected outputs are all inputs to the microcontroller. The current and voltage requirements have been examined and are expected to improve as a result of the improvements. The reference voltage control is essential for controlling switching frequency by modifying phase and load need by adjusting the PI control's gain parameters. First before signal is delivered to the Pwm inverter for pulse creation, it is corrected for harmonics. This multi-objective adaptable restrictions performance improvement controller is designed to function and upgrade for each moment of systems fluctuation in order to provide the best pulses and improved quality characteristics.

Fuel system integration

PEMFC is an electrochemical device that converts the chemical energy contained in a reaction between a fuel, hydrogen and an oxidizing agent, oxygen, into electrical energy. A bias voltage is applied to the electrochemical cell to induce electrochemical reactions on the two electrodes. Water is introduced into the anode and dissociated into oxygen, protons and electrons. Protons are driven by an electric field through the PEM to the cathode, where they combine with the electrons that come from the external circuit to form hydrogen gas.

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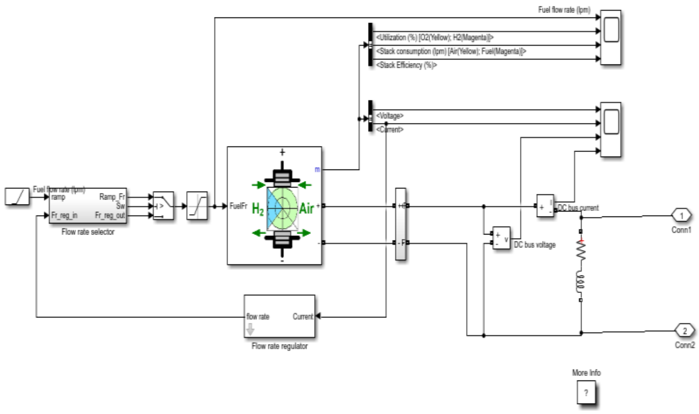

Fig.9 MATLAB/SIMULINK model of fuel system

Fuel cells are compact, low-noise energy generators that use hydrogen and oxygen to generate electricity. The transport sector is the most important potential market for fuel cells and car manufacturers invest heavily in research and development. However, energy production is seen as a market in which fuel cells can be marketed much faster. Fuel cells can achieve high efficiency (35% -60%) compared to conventional technologies. The figure shows the approach that has been followed to integrate the system with solar /wind energy system.

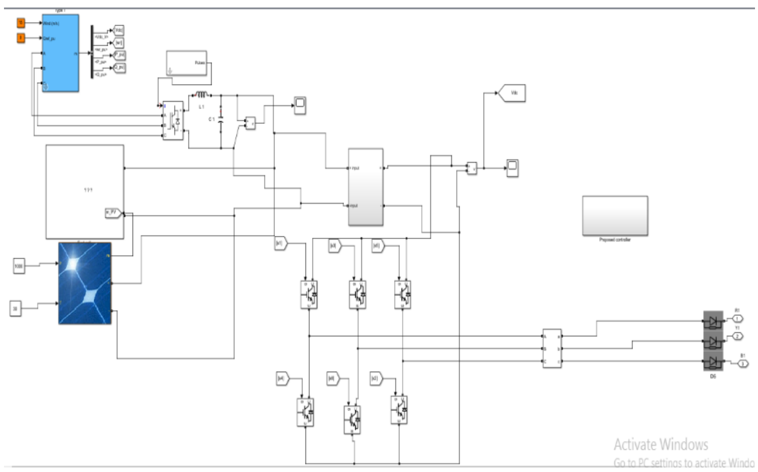

Fig.10 MATLAB/SIMULINK model for hybrid solar/wind/fuel cell system with proposed controller

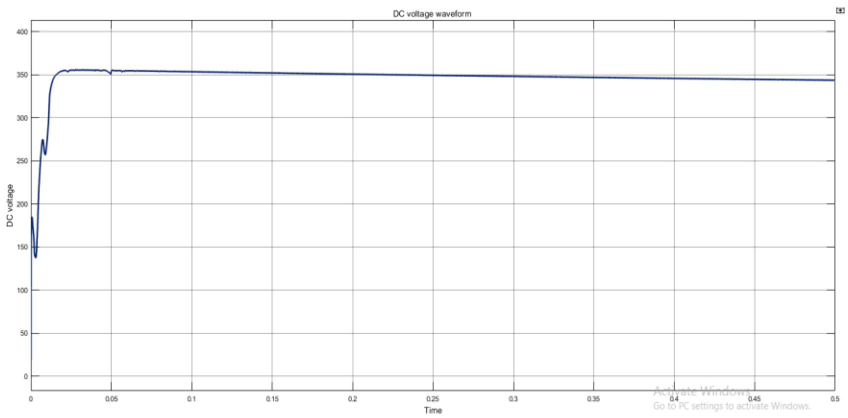

Fig.11 Common DC link voltage for all the energy resources

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The solar/wind/fuel energy system was configured were configured to be connected in parallel having common voltage the figure depicts the Common DC voltage line through which the three renewable energy resources are being connected it is maintained approximately to be 350 volts.

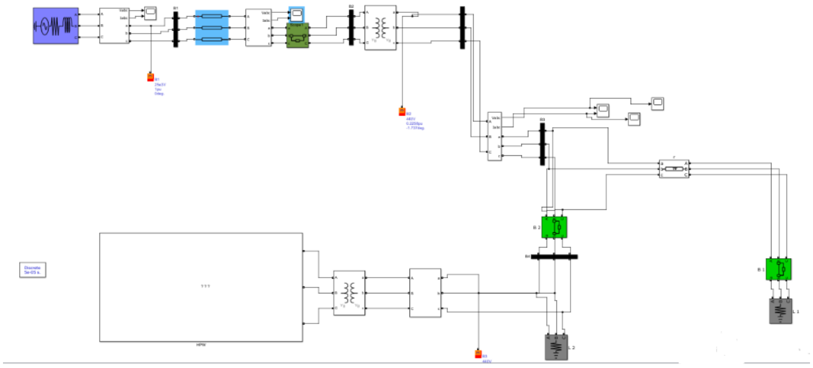

Fig.12 Grid Integration Of The Hybrid Systems

III. RESULT & DISCUSSION

Two or more renewable energy sources, power conditioning, and/or storage devices are used in a hybrid power system (HPS). HPS' major goal is to combine numerous forms of energy and/or storage systems that are complementary to one another. As a result, high performance can be attained by maximizing the benefits of each form of energy and/or device while addressing their constraints. The assessment of a combination solar panelsystem including basic dc power supply management for the inverters is done and the results. The actual output is then contrasted to some other software that involves a hybrid of solar, windy, and alternative fuel energy supplies, with the converter regulated by an identity evolutionary algorithms approach to improve all output parameters over the previous regime.

In this chapter, we looked at the output of a hybrid system with a stabilization in the following circumstances:

5.1 CASE 1: With a basic input voltage management, a hybrid Power system system can be interconnected with the grid.

5.2 CASE 2: Hybrid PV/wind/fuel system connected to the grid, with such a recommended met heuristic strategy for improving transformer performance.

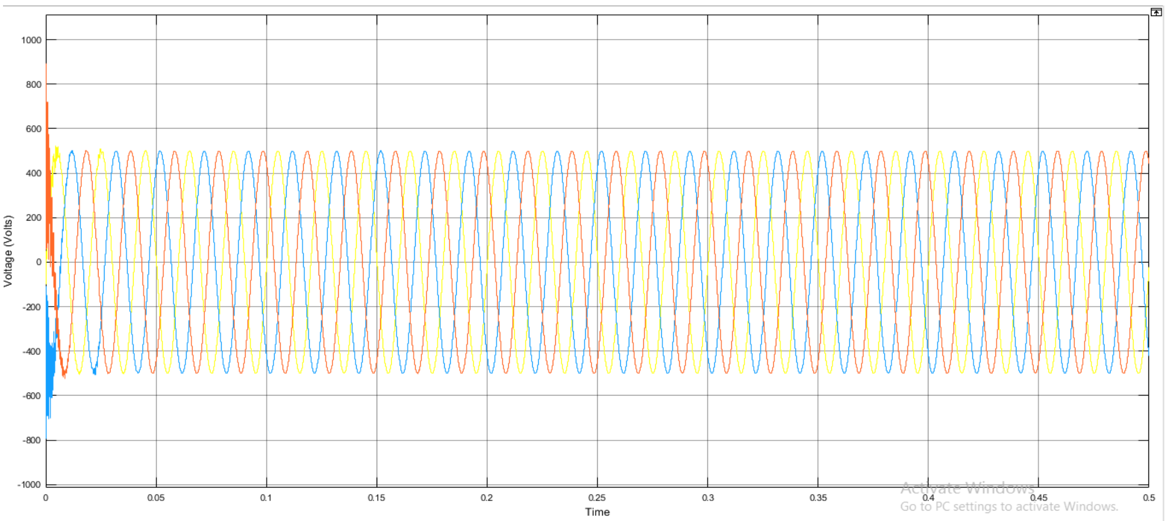

Fig.13 Voltage output from the solar/wind hybrid system with voltage source controller

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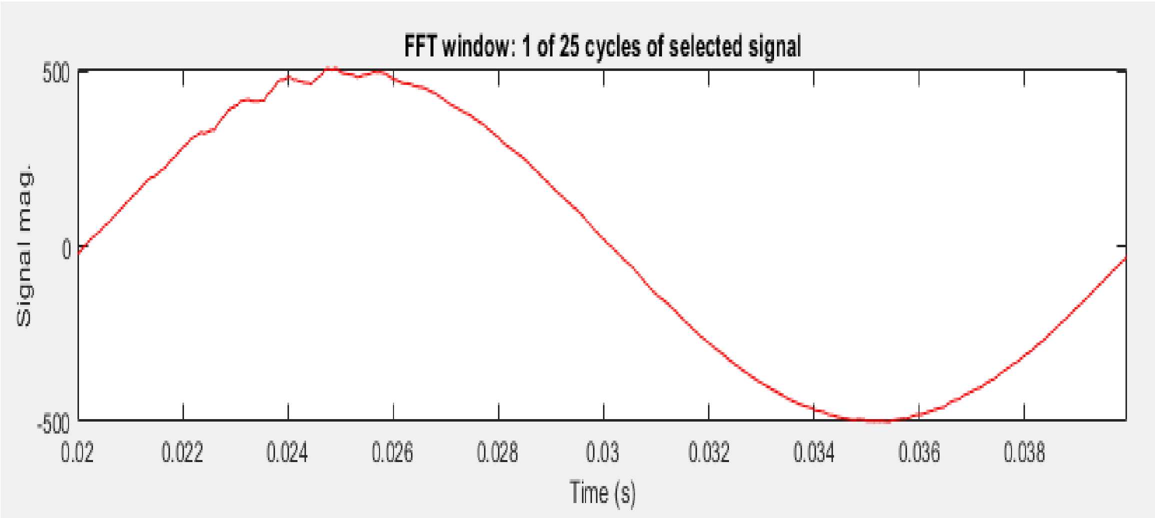

Fig.14 FFT analysis of voltage output from the solar/wind hybrid system

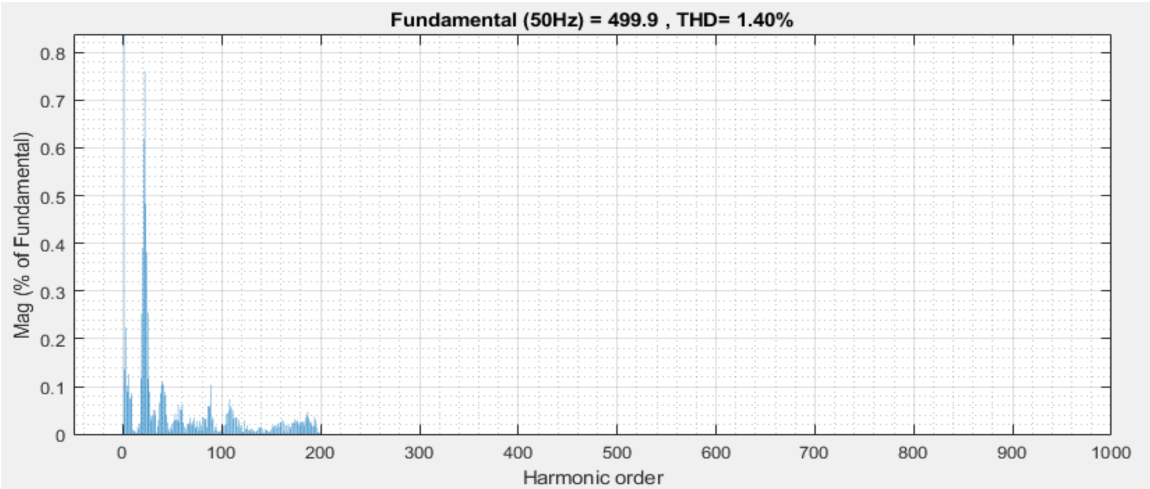

Fig.15 THD% in voltage output from the solar/wind hybrid system

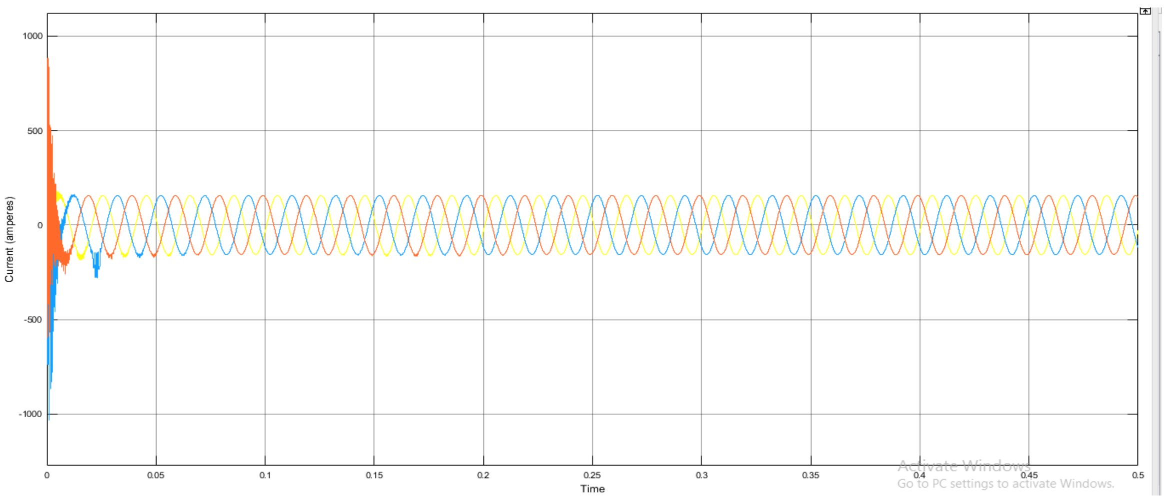

Fig.16 Current output from the solar/wind hybrid system with voltage source controller

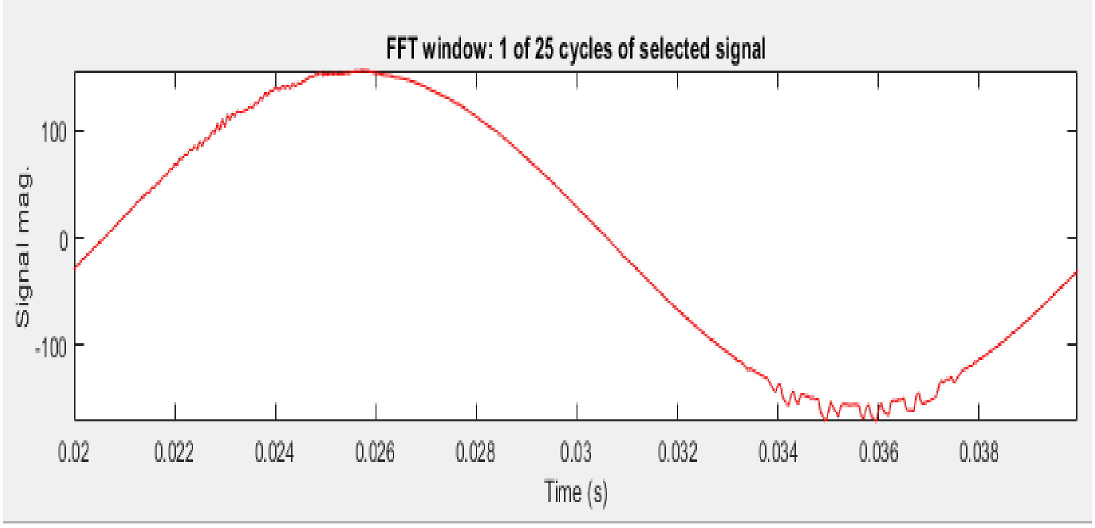

Fig..17 FFT analysis of Current output from the solar/wind hybrid system

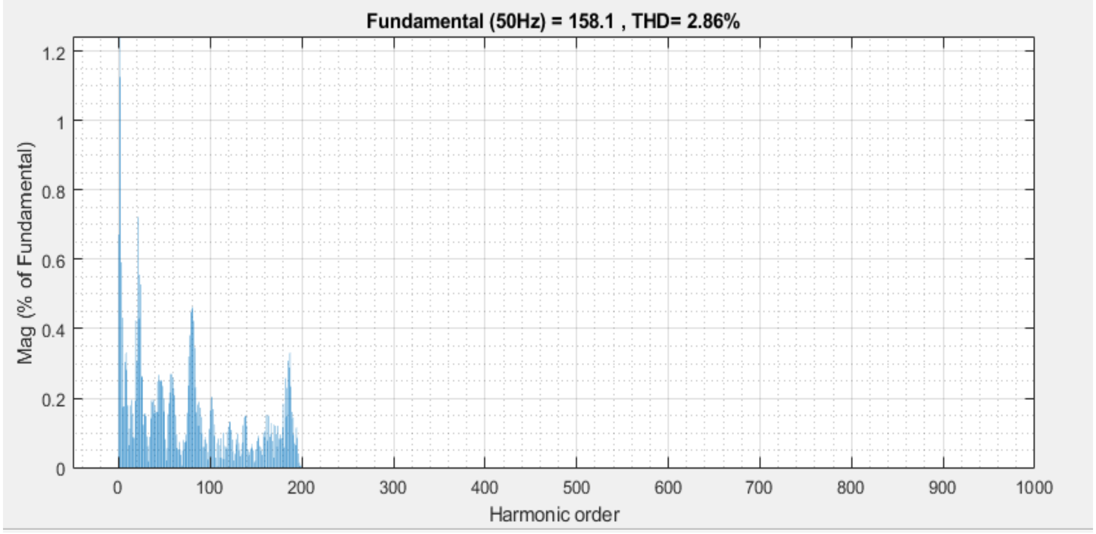

Fig.18 THD% in Current output from the solar/wind hybrid system

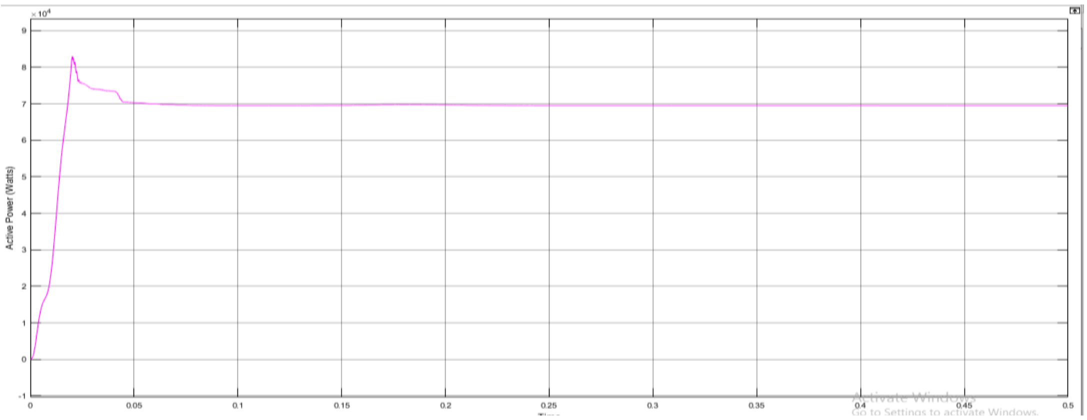

Fig.19 Active power output from the solar/wind hybrid system with voltage source controller

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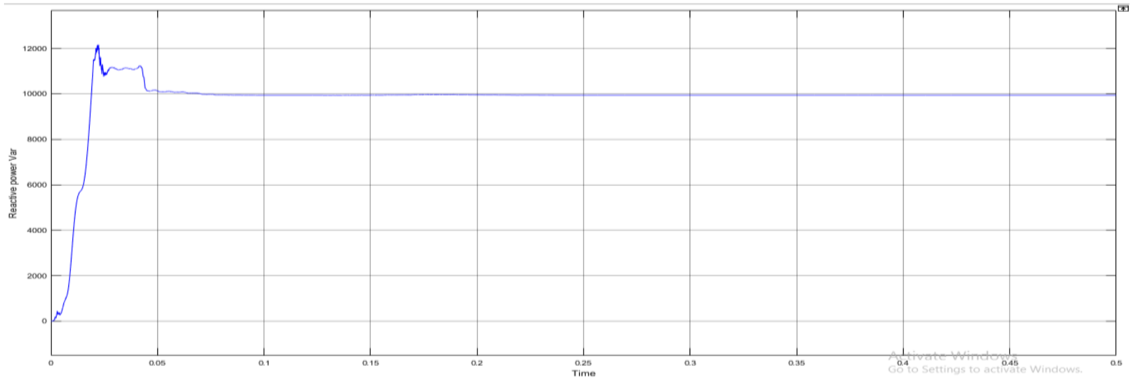

Fig.20 Reactive power output from the solar/wind hybrid system with voltage source controller.

The system voltage has been found to be 500 volts. The current output available at the load terminal after basic voltage regulation based control was found to155 amperes. On finding the active and reactive power outputs available at the load terminal in this case the results had shown approximately 70000 Watts output and approximately 9936 var output.

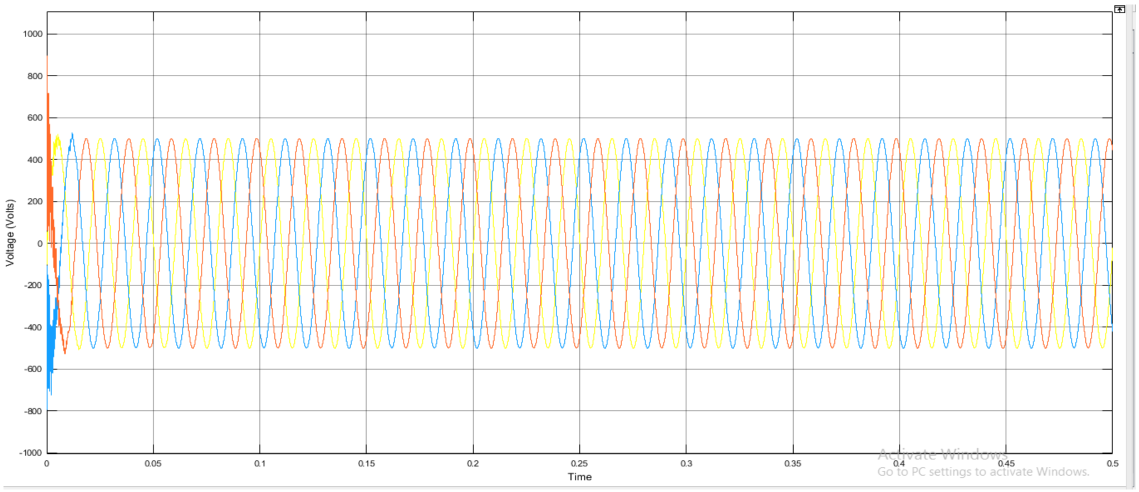

Fig.21 Voltage output from the hybrid solar/wind/fuel cell system multi objective adaptive constraints approach for quality enhancement controller

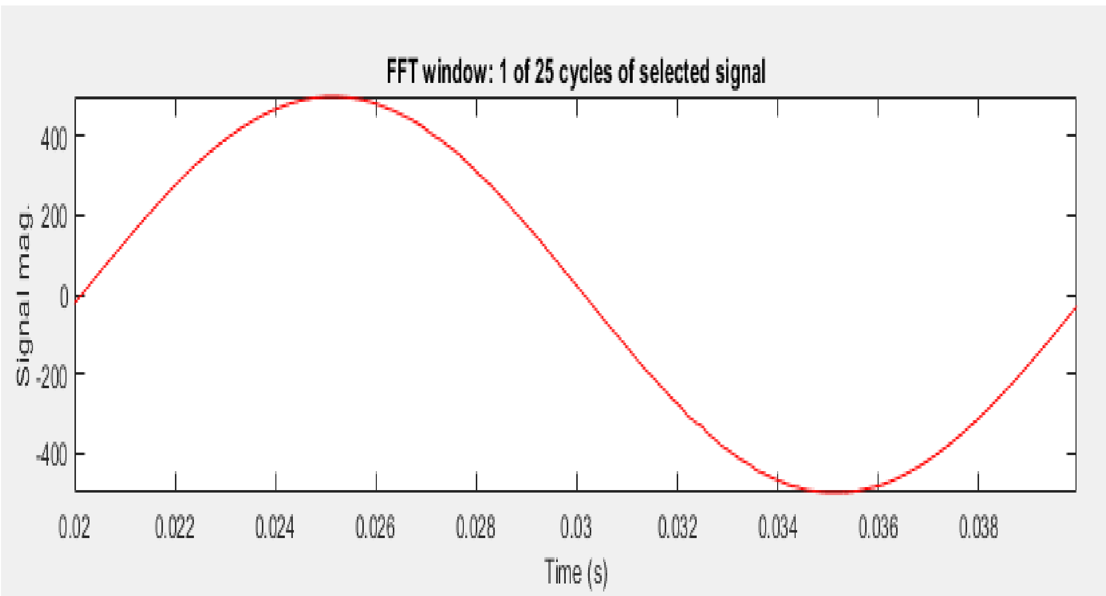

Fig.22 analysis of Voltage output from the proposed hybrid solar/wind/fuel cell system

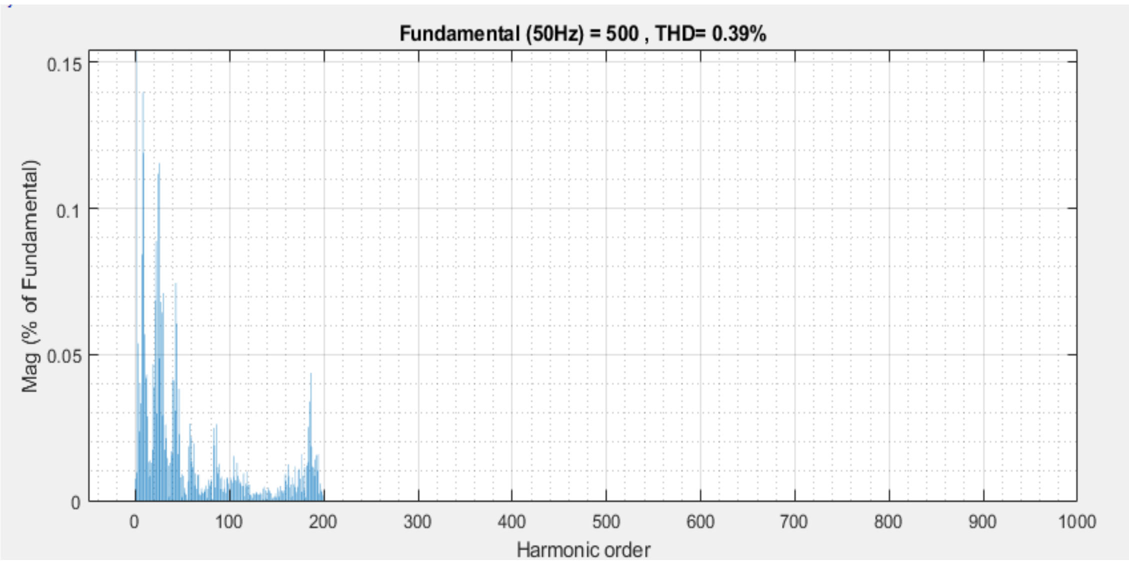

Fig.23 THD% in Voltage output from the proposed hybrid solar/wind/fuel cell system

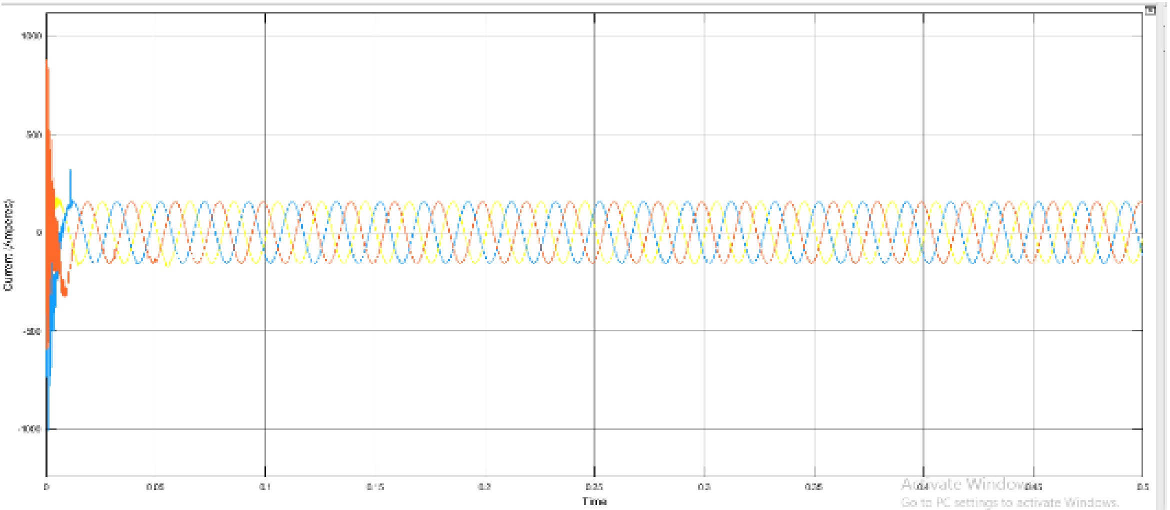

Fig.24 Current output from the hybrid solar/wind/fuel cell system multi objective adaptive constraints approach for quality enhancement controller

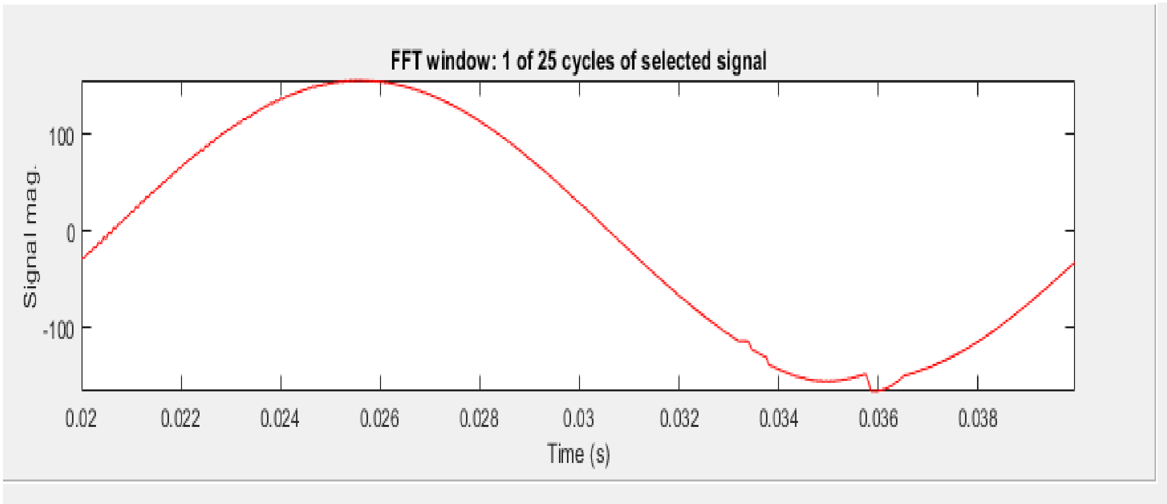

Fig.25 FFT analysis of current output from the proposed hybrid solar/wind/fuel cell system

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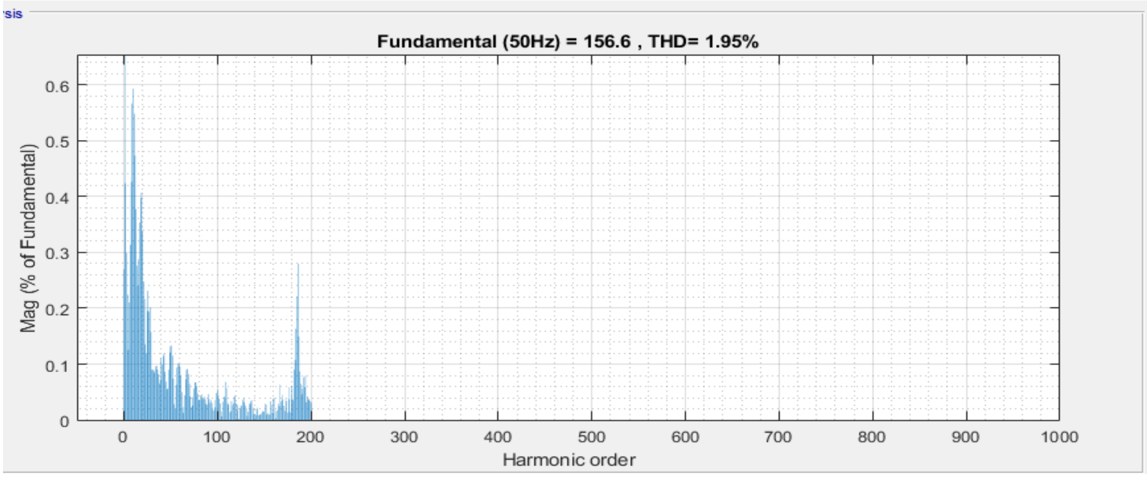

Fig.26 THD% in current output from the proposed hybrid solar/wind/fuel cell system

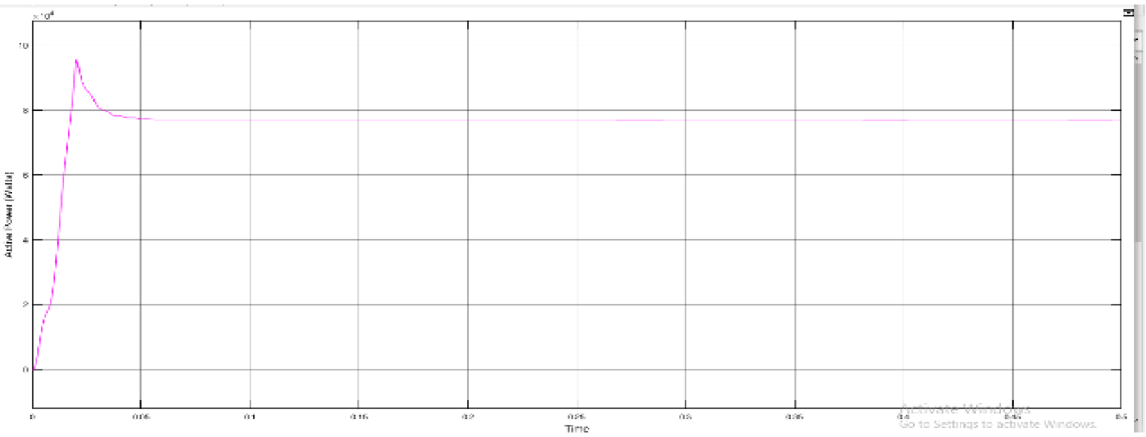

Fig.27 Active Power output from the hybrid solar/wind/fuel cell system having multi objective adaptive constraints approach for quality enhancement controller

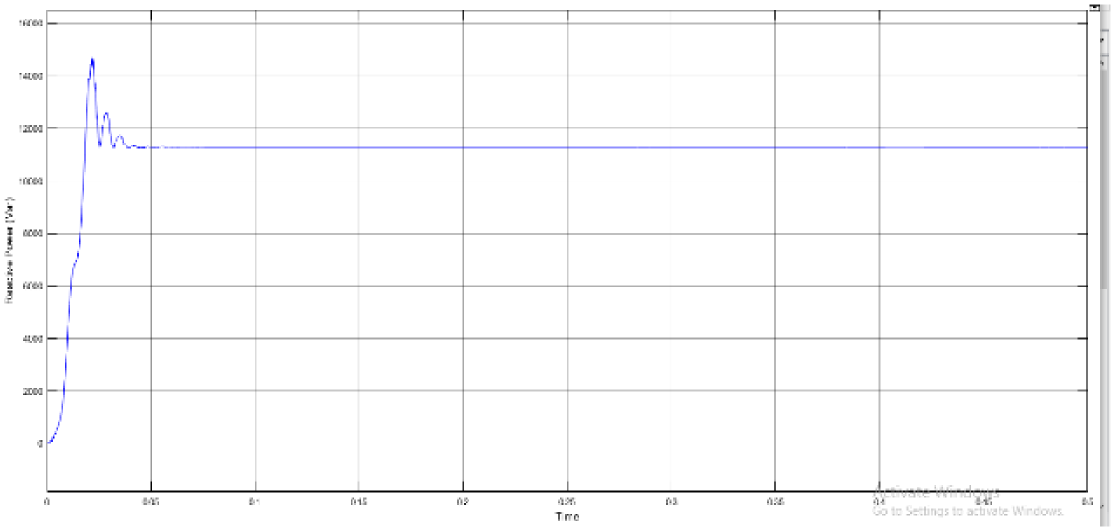

Fig.28 Reactive power output from the hybrid solar/wind/fuel cell system having multi objective adaptive constraints approach for quality enhancement controller

The system voltage has been found to be 500 volts. The current output available at the load terminal after proposed control was found to157 amperes. On finding the active and reactive power outputs available at the load terminal in this case the results had shown approximately 77090 Watts output and approximately 11300var output.

IV. Conclusion

Biological cycles continually replace renewable resources, often known as the non power sources. Hybrid methods are the best option for producing renewable energy. Surprising degree solar and wind energy resources is a practical way to generate electricity. A multilevel inverter is given for a hybrid windy photovoltaic energy and resource cell program that utilizes a Boost Converter and a suggested meta - heuristic optimization approach for transformer quality management. The operating optimization and electricity amperage management were created, and their functionality was proven using simulations.

Integrating all energy supplies to the dc bus requires the use of electrical machines. This management has the potential to improve the hybrid system's various parameters. The inverters regulator was created with the many aspects of the electricity system in consideration, as well as their development. The following are recommended results reached as a result of the research.

- The reactive power outputs waveform of the developed control were first evaluated for harmonics level distortions.
- The management was also studied for abrupt dynamic loading, and it was discovered that the proposed solution decreased current and voltage waveforms deformation. When comparing the suggested controllers to the input voltage and current, the deformation in the both the output current and voltage was determined to be reduced.
- The active power has increased in line with the growth in transformer input the 9936 W to 11300 W. The frequency deviation in the currents and voltages of the ultimate hybrid power system including hydrogen fuel incorporation was investigated. The deformation rate in the modulated signal was 0.39 percent, while it was 1.95 percent in the modulated signal. It's within IEEE's permitted limitations.

V. Future Scope

Installing this photovoltaic energy solution will be extremely beneficial because it will minimize utility dependence. But at the other hand, this approach encourages the use of renewable technology, which is critical even though all power sources are rapidly decreasing. As a result, people must seek for green energy sources, and renewable energy is unquestionably one of the greatest options. In the future, a multilayer perception internet management for enhanced power supply will be investigated. For this system with three sources . these sources of solar/wind/fuel cell powered mixed power train, a three - phase power grid having complex nonlinear loads will be constructed. The anticipated control strategy effectively manages the voltage regulation and enhances power.

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