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"HYBRID RENEWABLE ENERGY BASED SINGLE PHASED OF V2G AND G2V"

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ABSTRACT

This system is economically justifiable given to the elimination of the PV dedicated converter and can inject the PV output power into the grid more efficiently. The results are simulated in the MATLAB/SIMULINK software environment. The dynamic model is developed using the machines equivalent circuit and is expressed in the stationary, rotor and the synchronous reference frames for evaluating the performance of the machine. The stator of the DFIG is directly interfaced to the grid and by controlling the rotor voltage by a two-level back-to-back converter the grid synchronization and power control is maintained. The Grid Side Converter (GSC) is modified for feeding regulated power to the grid. Rotor Side Converter (RSC) is controlled for achieving MPPT and Unity Power Factor (UPF) and with and without PV system Both Simulation done in MATLAB and Voltage, Current, real and reactive power for input and output Result carried.Wind power is one of the most developed and rapidly growing renewable energy sources. The thesis is dedicated to an in-depth analysis of DFIG PV and wind energy generators, system configurations, power converters, control schemes and dynamic and steady state performance of practical wind energy conversion systems (WECS). This thesis focuses on method for controlling the DC link voltage and maximum power point tracking (MPPT) of the photovoltaic (PV) system in a hybrid PV-wind turbine system is introduced. The system under study is a modified PV-DFIG structure. In this system, the PV output power is injected into the grid through the both grid-side and rotor-side converters of the DFIG. The proposed control system controls the DC-link voltage and the MPPT of the PV system together.

Key Words: *DC-link, Photovolatic, Unit Power factor, Matlab.*

I. INTRODUCTION

Renewable energy is power derived from natural possessions, such as solar, wind, waves, or geothermal energy. These resources are renewable and can be recycled naturally. Therefore, compared to the depletion of traditional fossil fuels [1], these sources of information are considered inexhaustible. The global power crunch provides a new impetus for the development or maturity of clean or renewable energy. [2]. In addition to the decline in fossil fuel transportation worldwide, another major reason fossil fuels do not work is the pollution associated with burning fossil fuels. In contrast, it is well known that compared to traditional energy sources, renewable energy sources are cleaner, or energy produced has no adverse effects on pollution.
Correspondingly, the solar power generation system is proposed in Figure 1.2. A solar cell or panel comprises a model derived from solar cells connected in series or parallel to provide the required currents and energy. solar intertie photovoltaic (PV) systems are not particularly complex. First there are panels, which collect the sunlight and turn it into electricity. The DC signals are fed into an inverter, which converts the DC into grid-compatible AC power (which is what you use in your home). Various switch boxes are included for safety reasons, and the whole thing is connected via wires and conduit.

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Storage batteries can provide protective power during periods of free sunlight by storing more or part of the power from solar panels. Solar power generation systems are used for private power consumption, weather stations, radio or television stations, entertainment venues, such as cinemas, hotels, restaurants, villages, and islands. The traditional p-n junction solar cell is the most advanced solar energy collection technology. The fundamental physics of energy input and carrier output functions the physical properties and the associated electrical properties (i.e., the band distance). The electron needs to have energy greater than the bandgap to excite electrons from the valence band to the conduction band. An ideal solar cell has a direct band gap of 1.4 eV to absorb the maximum number of photons from the sun's radiation. The seemingly infinite lattice creates bands of allowed energy states; silicon creates a band gap where no electrons exist (a band gap that is 1.1 eV wide. However, the sun's radius is close to the black spectrum of about 6000 K. Therefore, most of the rays from the sun reaching the earth have a source of energy greater than the radius of the sun silicon group. These high-energy phonons will be cured by solar cells. Still, the distance between the phonons and the silicon band will be converted to heat (via an overflow called phonons) instead of usable energy. For a single meeting cell, this will set a maximum efficiency of around 20%. Current research methods to perform multi-node photovoltaic design to overcome efficiency limits do not seem to be an expensive solution. Even a built-in PV device can only be used during the day and needs direct sunlight (directly connected to the interior) for optimum performance.

The major components of a wind turbine system are shown in Figure 1.9 (drawing not to scale). The turbine is formed by the blades, the rotor hub and the connecting components. The drive train is formed by the turbine rotating mass, low-speed shaft, gearbox, high-speed shaft, and generator rotating mass. It transfers turbine mechanical output power up to the generator rotor where it is converted to electrical power. The wind strikes the rotor on the horizontal-axis turbine, causing it to spin. The low-speed shaft transfers energy to the gear box, which steps up in speed and rotates the high-speed shaft. The high-speed shaft causes the generator to spin, hence generating electricity. The yaw system is used to turn the nacelle so that the rotor faces into the wind. The low-speed Shaft contains pipes for the hydraulics system that operates the aerodynamic brake. The high-speed shaft is equipped with an emergency mechanical brake which is used in case of failure of the aerodynamic brake [12].

The generator converts mechanical power of wind into electrical power. Usually, the generator produces power at low voltage and the transformer steps up the generator output voltage to connected grid voltage. The transformer may be placed at the bottom of the tower [4] or in the nacelle for losses minimization [13].

Other components of wind turbine system are the anemometer to measure wind speed and a wind vane which measure the wind direction. Wind speed information is used to determine when the wind speed is sufficient to start up the turbine and when, due to high winds, the turbine must be shut down for safety whereas wind direction measurement is used by the yaw-control mechanism which helps in orienting the rotor to the wind direction [14]. Electric fans and oil coolers are used to cool the gearbox and generator.

II. RELATED WORK

Hossein Gholizadeh et.al. 2021 - In this study a transform-less high step-up converter has been proposed. The topology of the proposed converter has been built up based on the conventional boost converter and has been modified by two voltage multiplier cell. The mentioned converter has been designed for the continuous current mode. The voltage ratio of the proposed converter has been extracted for both ideal and non-ideal mode. The non-ideal voltage ratio of the proposed converter has been compared with other high step-up DC-DC converters. Moreover, the practical voltage ratio of the converter has been extracted and compared with the result of the relation of the non-ideal voltage gain. Finally, the simulation results have been extracted and compared with experimental results. The PLECS is the simulation engine which has been used in this study.

Hiroaki Matsumori et.al. 2021 -This paper presents an isolated step-sown DC-DC converter using GaN power device for automotive applications. The works for a power supply from a high voltage main battery with 200V to low voltage auxiliary battery with 13.6V in hybrid electric vehicle. A LLC converter is known as isolated DC-DC converter with high-efficiency. However, when input and/or output voltage considerably fluctuates, efficiency of a LLC resonant converter becomes worse. In order to solve this problem, a DC-DC boost-up converter to mitigate efficiency deterioration for the input and/or output voltage fluctuation is added to a LLC resonant converter. Generally speaking, an additional circuit, the boost-up chopper in this case, also deteriorates the total system efficiency. To avoid the efficiency degradation, discontinuous current mode control and GaN power devices are applied to the boost-up

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chopper. The DC-DC boost-up converter experimentally achieves 99.03% of conversion efficiency at nominal output so that it has no effect on the total system efficiency. Even though adding a DC-DC boost-up chopper to the LLC resonant converter, a power density expected to 10 W/cc.

III. CONCLUSION

This work proposes the grid interfaced DFIG based WECS for power smoothening. The rotor position computation algorithm is used for the estimation of rotor position [24]. The novelty of the work lies in the control of GSC (Grid Side Converter). So, the authors have clearly demonstrated the control algorithm for feeding regulated power to the grid. The selection of BESS is the other important aspect of DFIG based WECS for power smoothening. The variations in the powers with the increase in wind speeds are demonstrated by comparing the conventional DFIG and the proposed DFIG. The operation of the system is experimentally validated for regulating the power of DFIG even under variable wind speed conditions.

The grid-interfaced DFIG-based WECS is proposed for power smoothing in this paper. For rotor position estimation, the rotor position computation method is utilised [24]. The work's uniqueness comes from GSC's control (Grid Side Converter). The control algorithm for providing regulated electricity to the grid has therefore been explicitly proven by the authors. Another essential feature of DFIG-based WECS for power smoothening is BESS selection. When comparing the standard DFIG with the suggested DFIG, the differences in powers with increasing wind speeds are displayed. The system's functioning has been experimentally confirmed for controlling DFIG power under fluctuating wind speed circumstances. The Simulink design in this proposed DFIG system with solar and without solar.

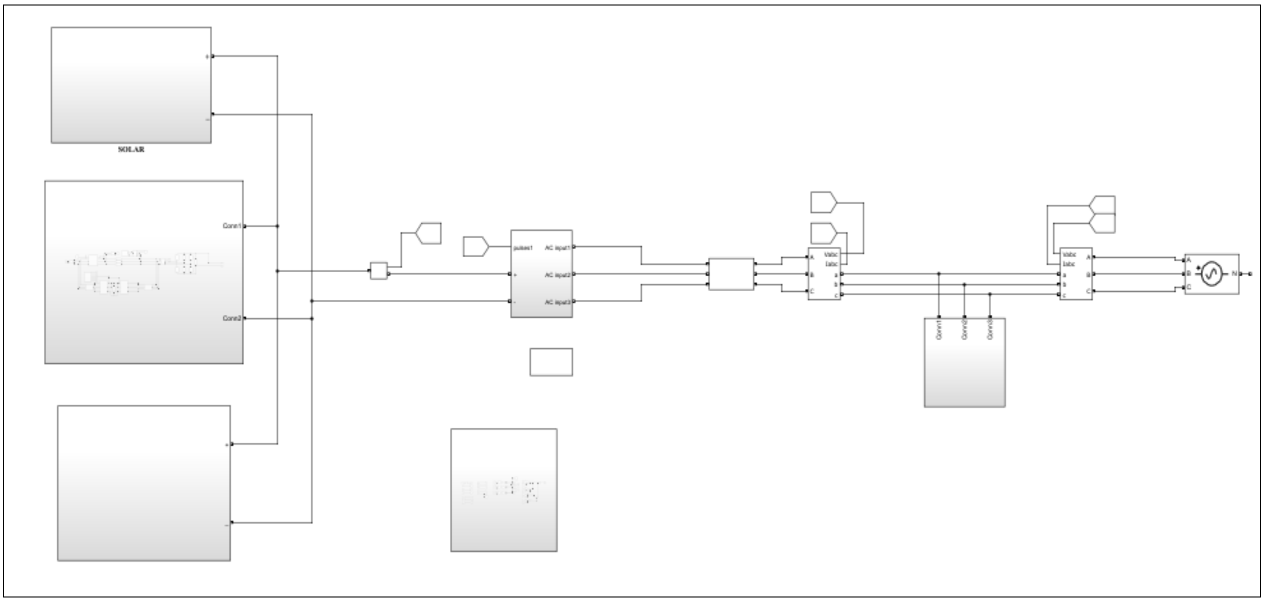

Figure 1: Proposed Simulink Model

MATLAB Simulation Without Solar : Figure 1 shows a schematic representation of the proposed grid interfaced DFIG based WECS. The BESS is linked to the DC connection of two VSCs that are connected back-to-back. The stator is directly linked to the grid in this case. In a voltage-oriented reference frame, RSC is regulated. EPLL is used to align the d-axis of the synchronously rotating reference frame with the voltage axis (Enhanced Phase Locked Loop). The rotor position computation technique is utilised to estimate the location here. The GSC is set up such that the regulated electricity is supplied into the grid. When the generated power exceeds the regulated power, the leftover energy is stored in the BESS. If the amount of energy generated is less than the regulated amount, the BESS feeds the leftover energy to the grid. Figure 2 depicts the control algorithms.

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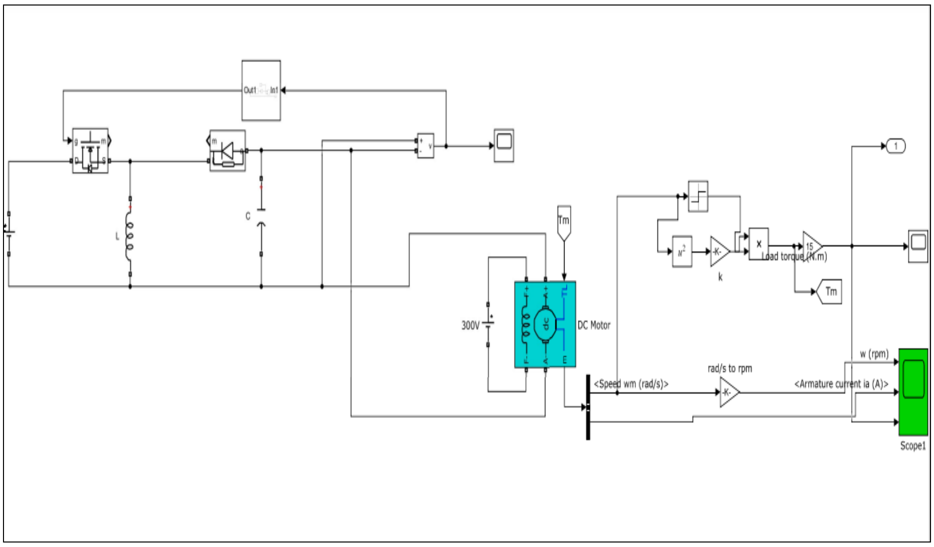

Figure 2: DC machine

Implements a (wound-field or permanent magnet) DC machine. For the wound-field DC machine, access is provided to the field connections so that the machine can be used as a separately excited, shunt-connected or a series-connected DC machine.

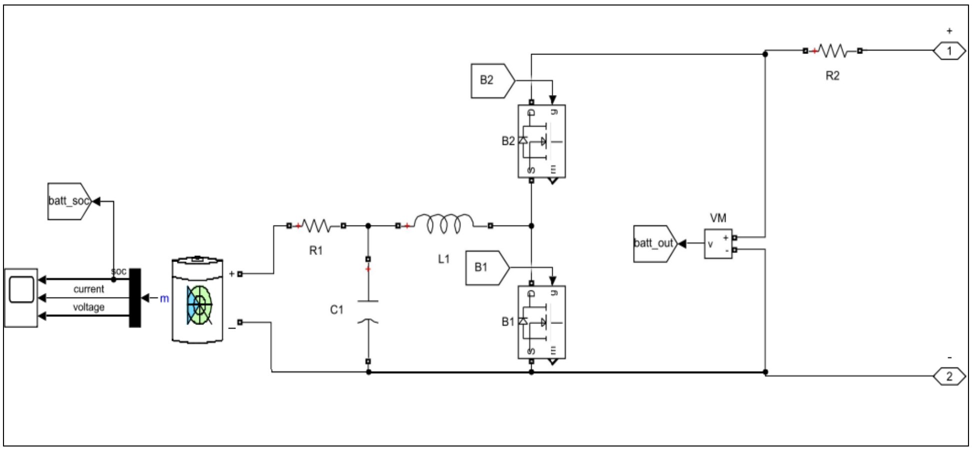

Figure 3: Battery Simulink Model

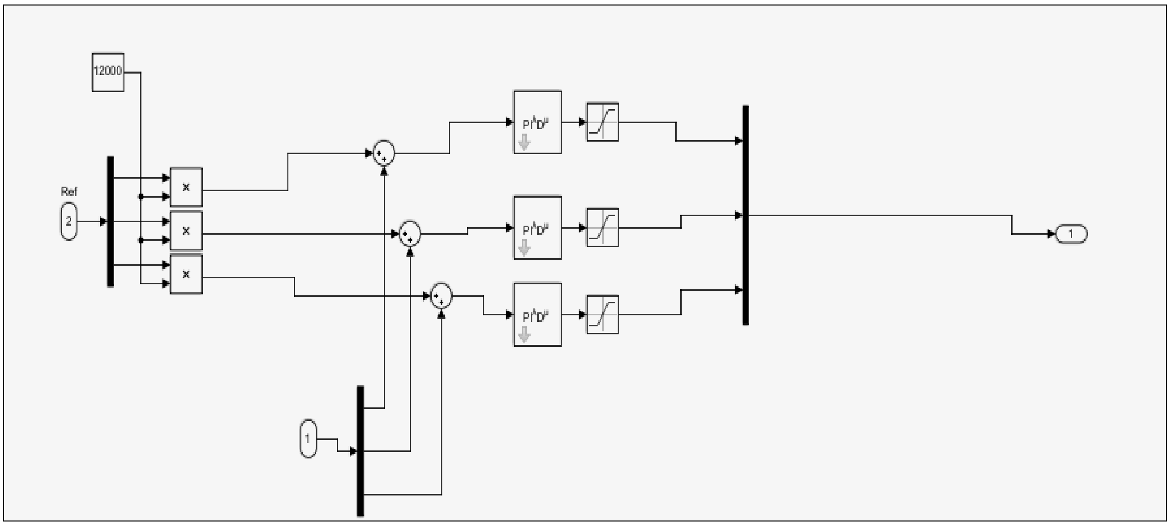

Figure 4: Fractional PID

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SJIF Impact Factor : 6.008

MATLAB IMPLEMENTATION WITH SOLAR

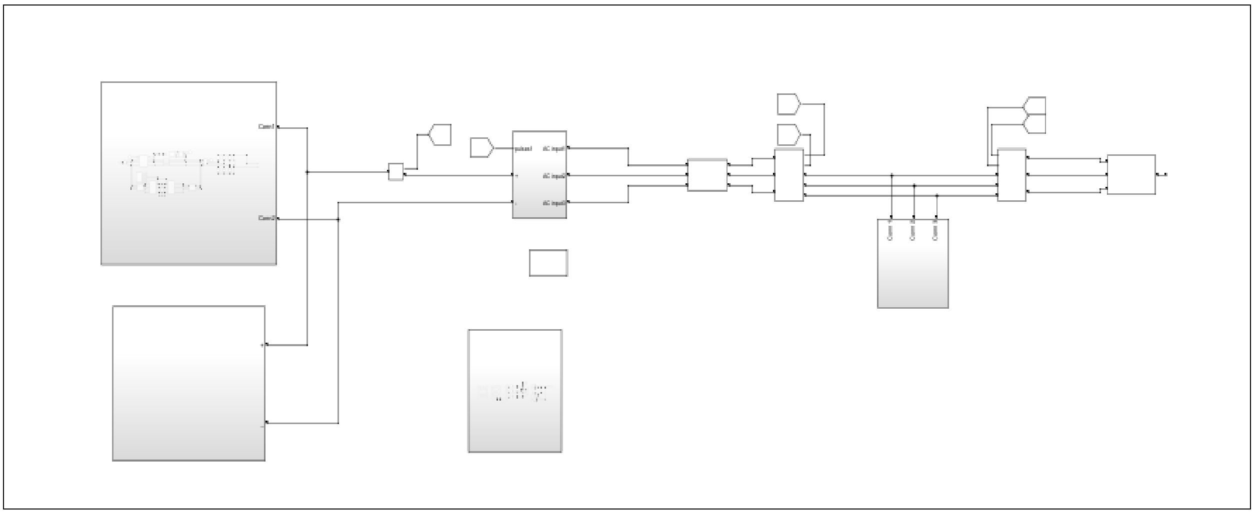

Figure 5 Proposed Simulink Model with Solar Panel

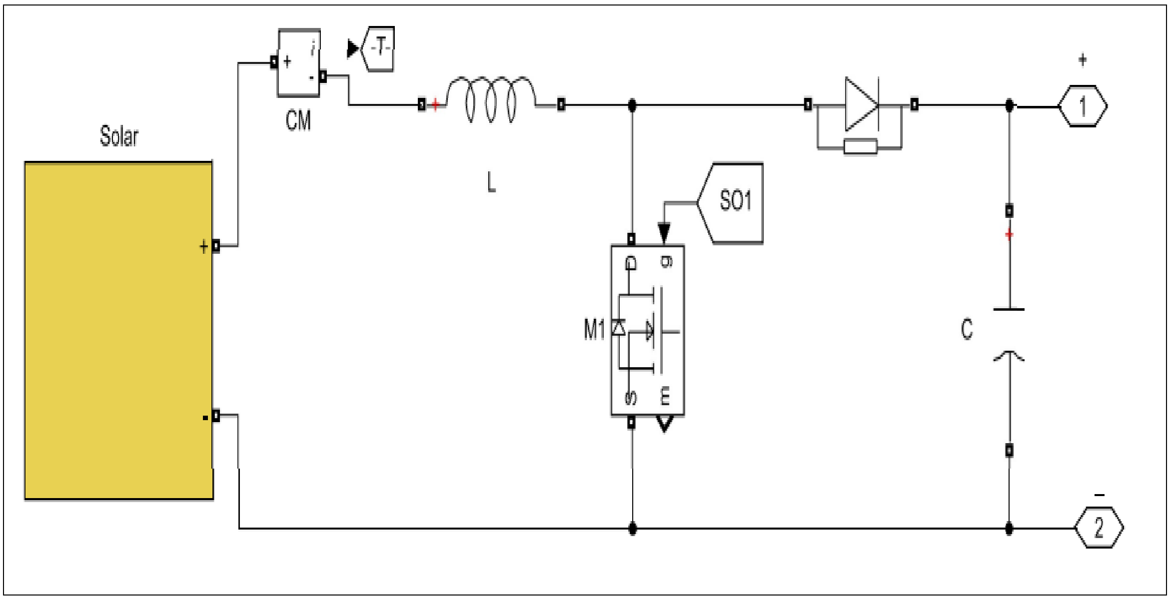

Figure 6: Solar System

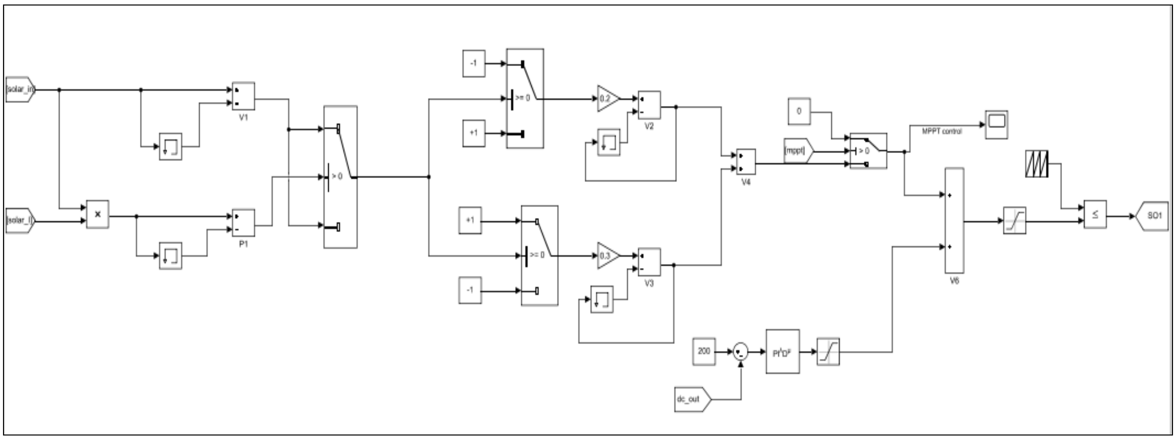

Figure 7: MPPT Control

ISSN : 2455-9679
SJIF Impact Factor : 6.008

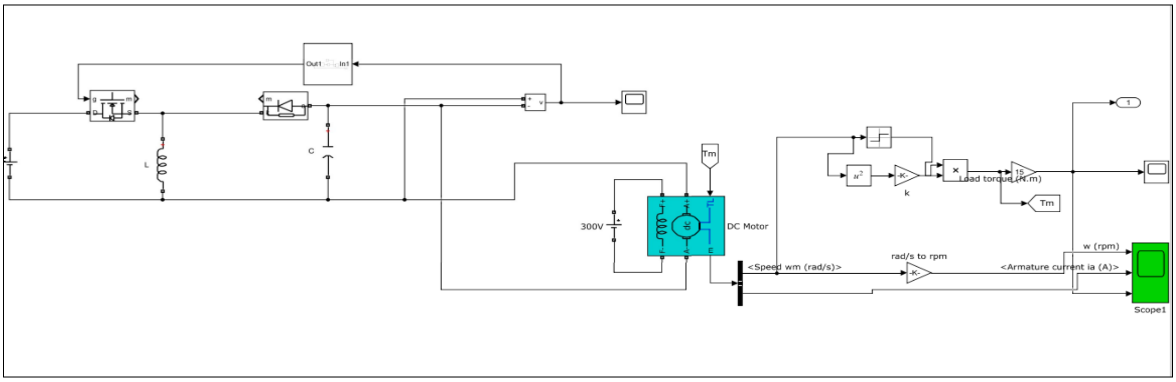

Figure 7: Dc Machine

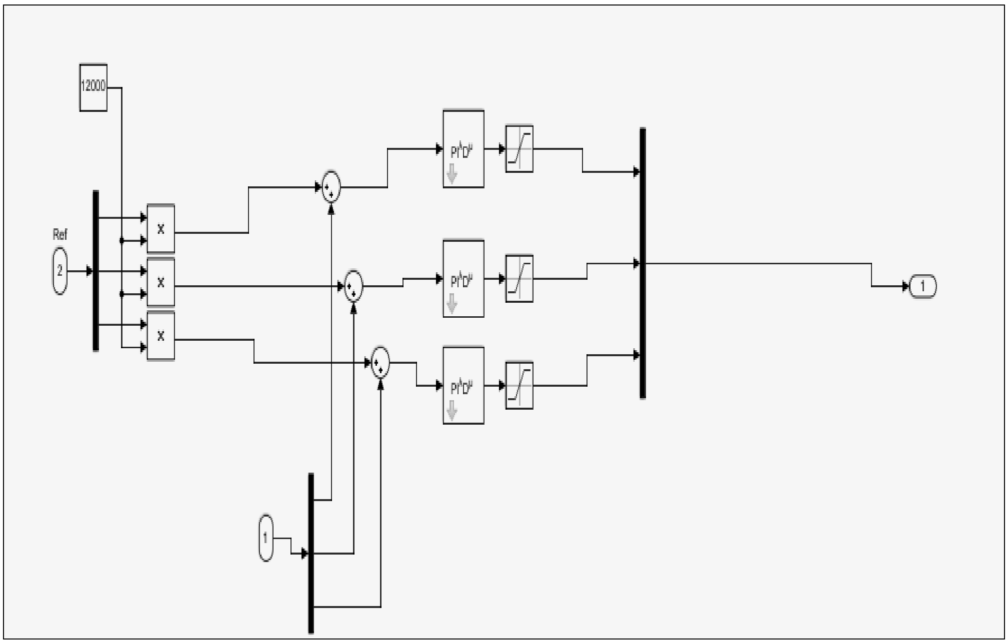

Figure 8: Fractional PID

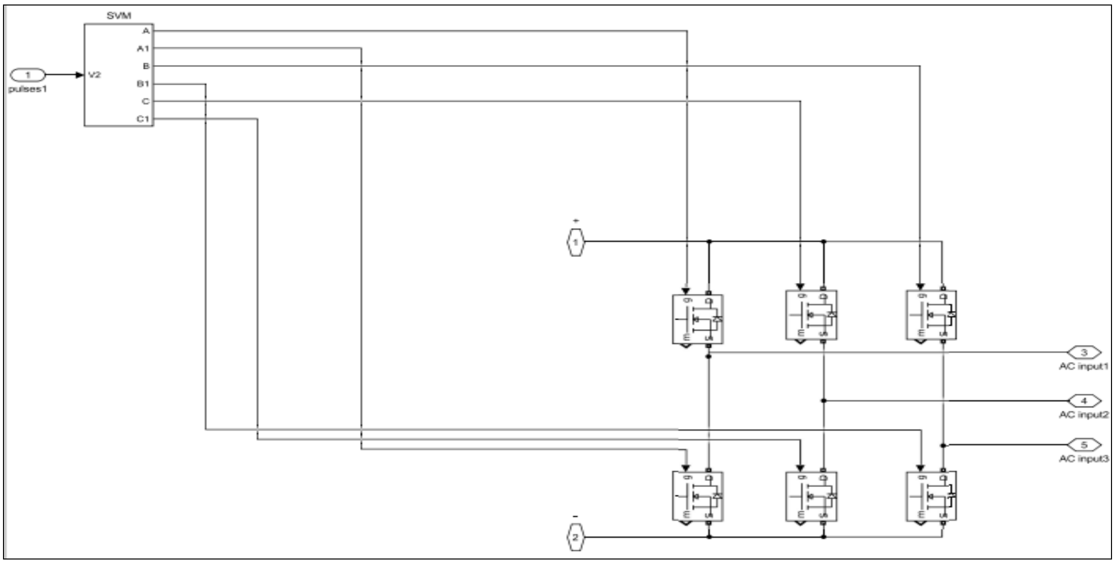

Figure 9: SVM Subsystem

ISSN : 2455-9679
SJIF Impact Factor : 6.008

III. SIMULATION RESULT

The parameters of the PV panel, wind turbine and DFIG,. Simulation is done on MATLAB 2019b and results shown below. Generated voltage of solar PV system is not sufficient since a boost converter is used for rise of voltage.A detailed electromechanical model of a DFIG-based wind turbine connected to power grid as well as autonomously operated wind turbine system with integrated battery energy storage is developed in the MATLAB/Simulink environment and its corresponding generator and turbine control structure is implemented. A thorough explanation of this control structure as well as the steady state behavior of the overall wind turbine system is presented. The steady state reactive power capability of the DFIG.

SIMULATION RESULT WITHOUT SOLAR AND DFIG

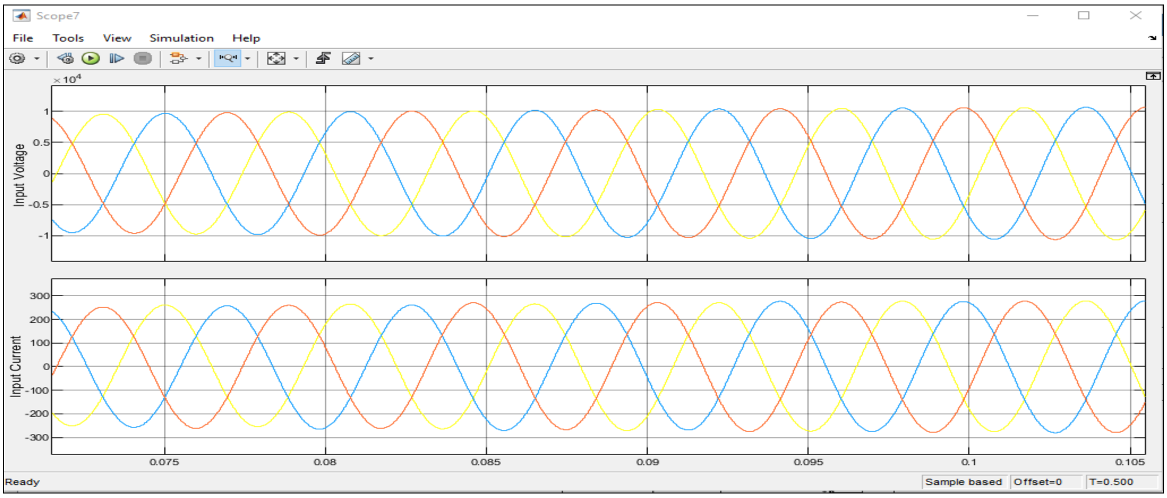

Figure 10: Input Voltage and Current

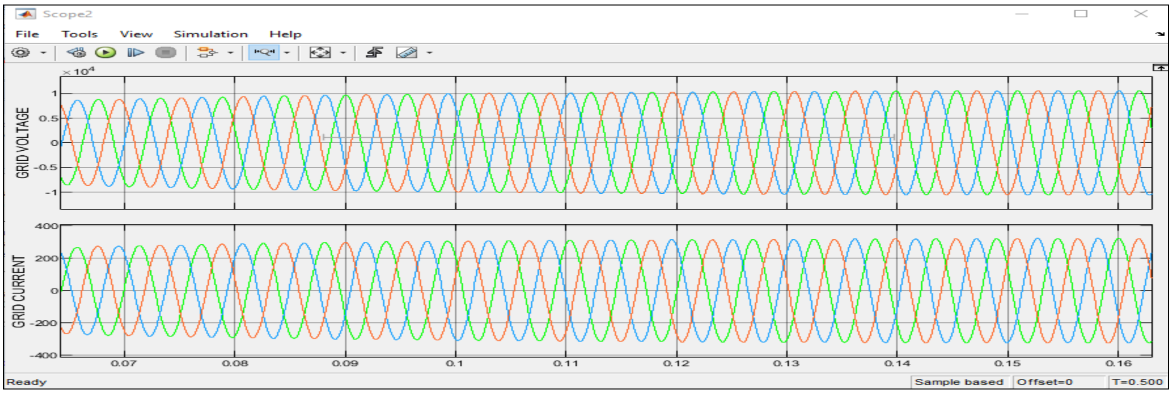

Figure 11: Grid Voltage and Current

Figure 11 showing the Grid Voltage and Current waveform, during simulation grid voltage generate 230v

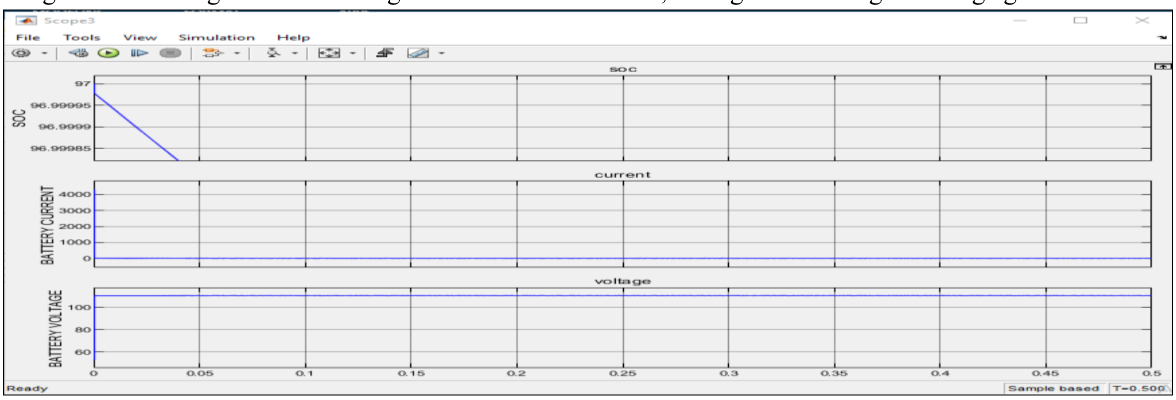

Figure 12: Battery Output

ISSN : 2455-9679
SJIF Impact Factor : 6.008

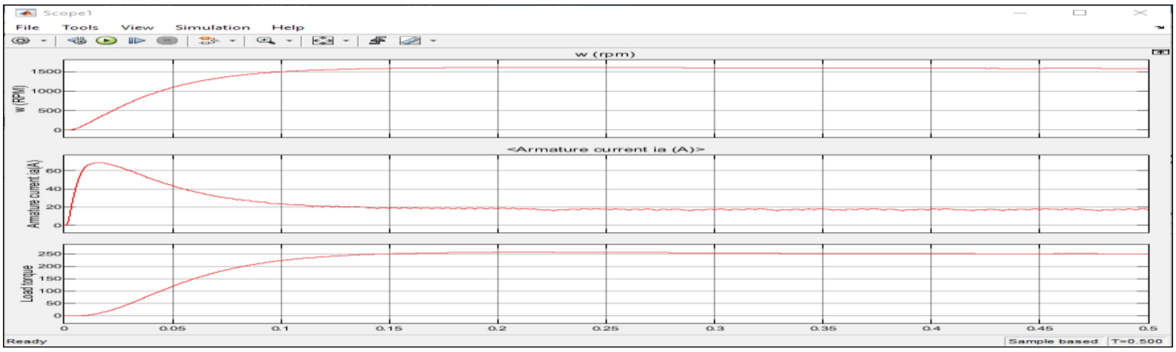

Figure 13: DC Machine Output

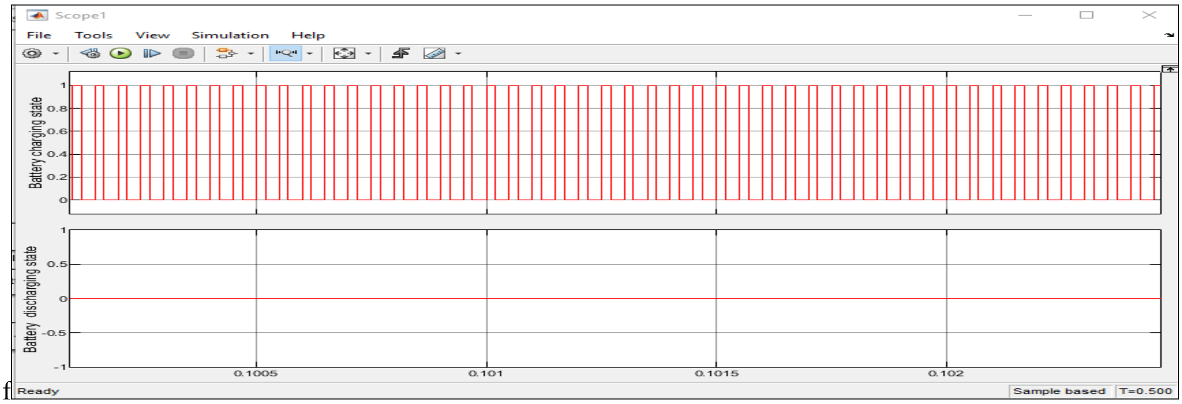

Figure14: Battery Charging and Discharging States

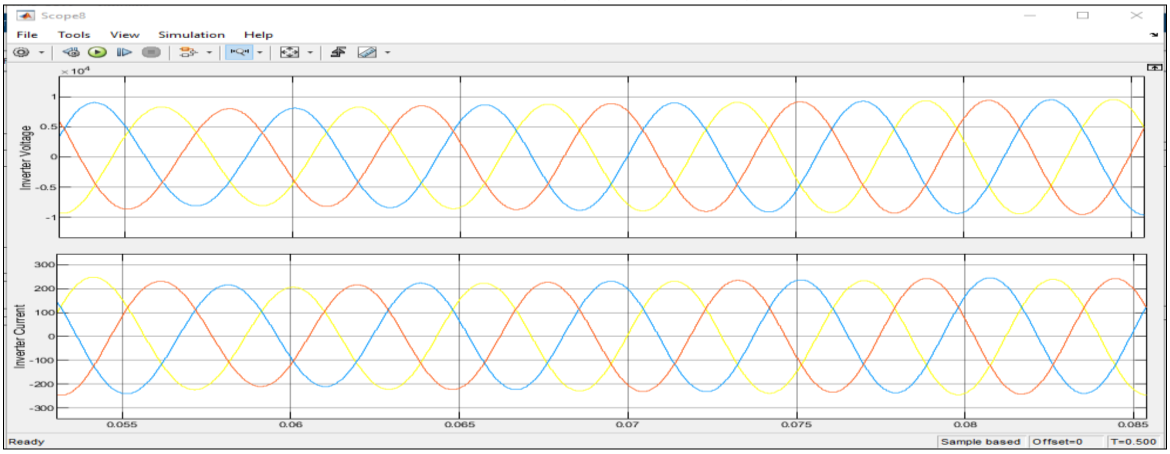

Figure 15: Inverter Current and Voltage

SIMULATION RESULT WITH SOLAR AND DFIG

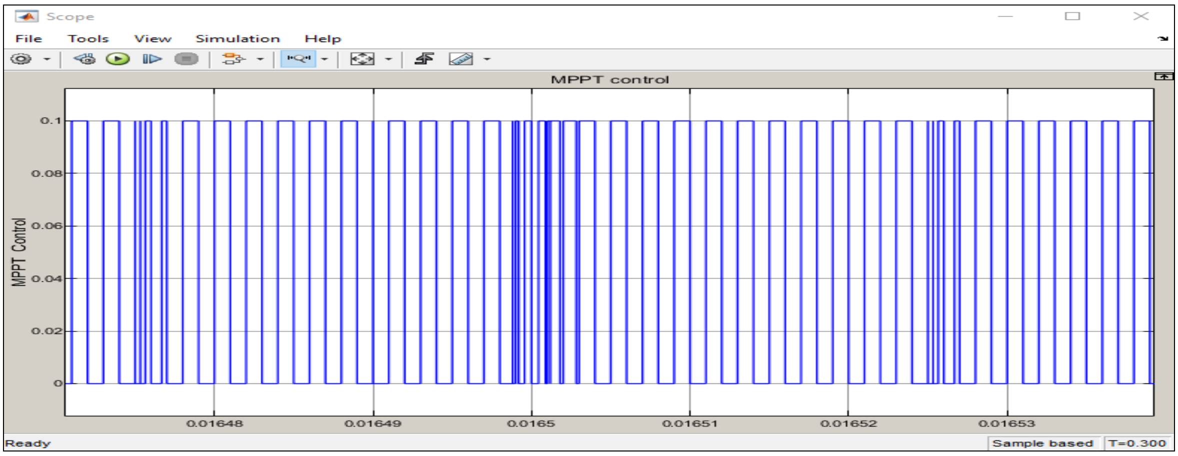

Figure 16: MPPT Control

ISSN : 2455-9679
SJIF Impact Factor : 6.008

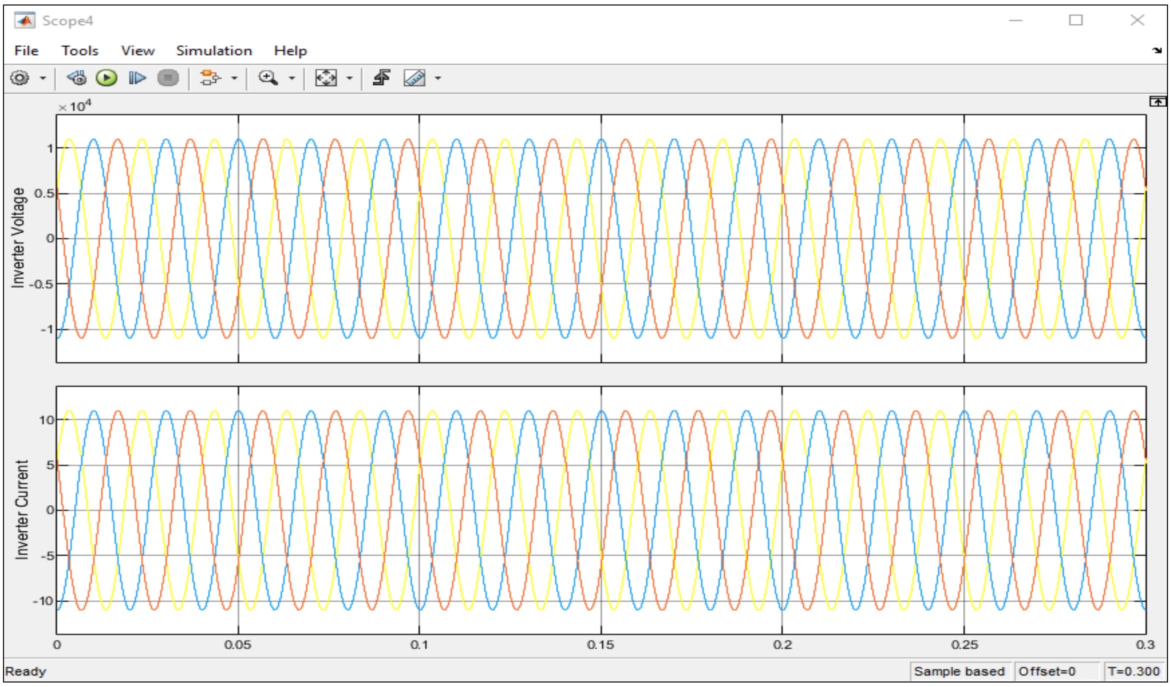

Figure 17: Input Voltage and Current

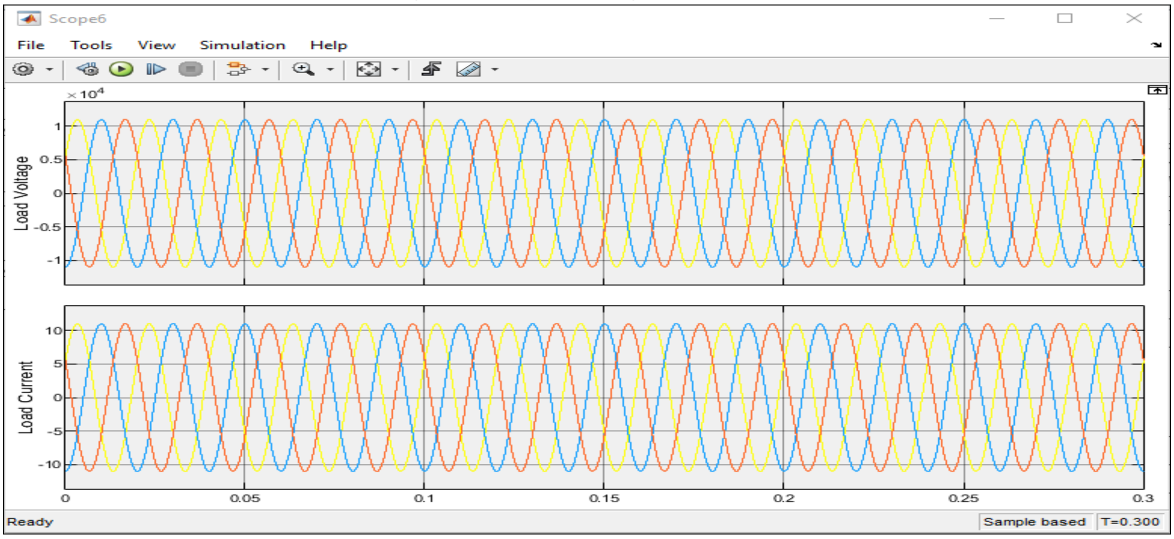

Figure 18: Load Voltage and Current

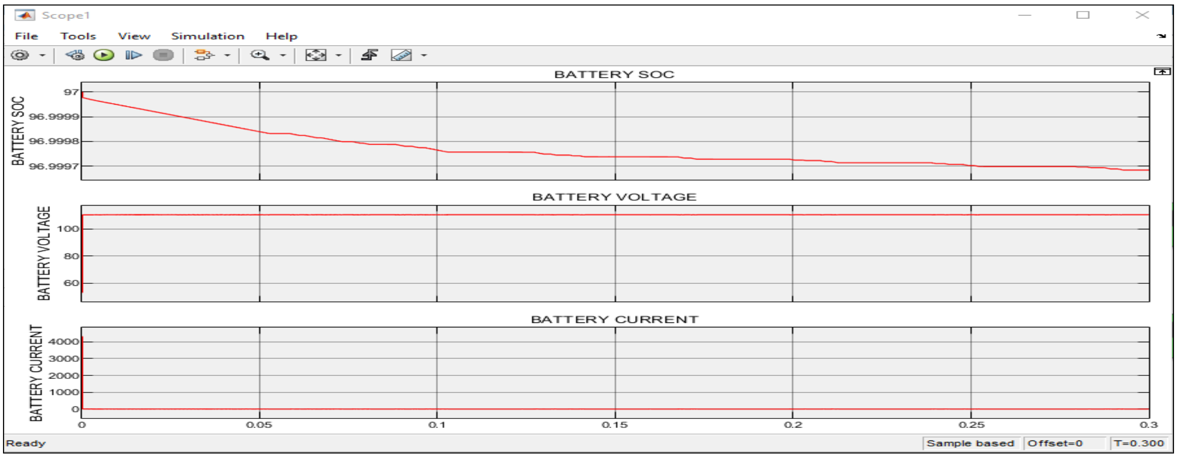

Figure 19: Battery Output

Fig 19 showing the battery output ,Power capacity is how much energy is stored in the battery.

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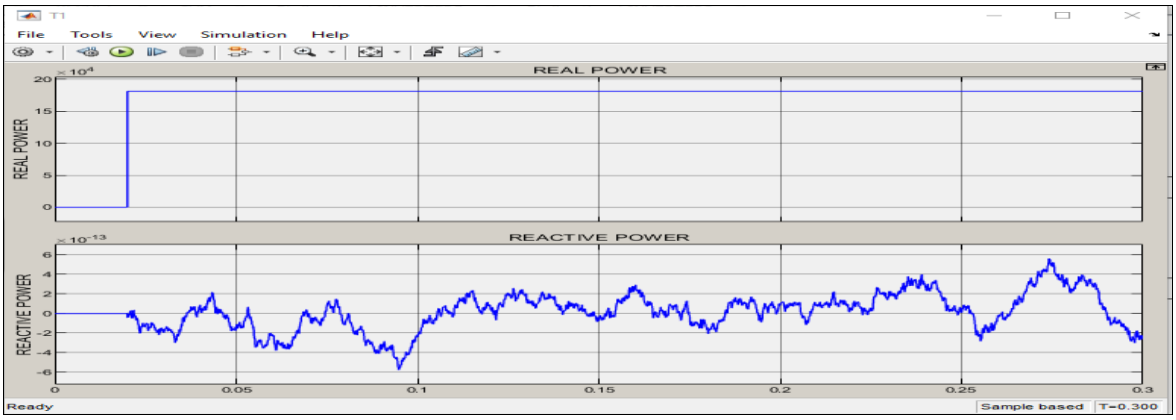
SJIF Impact Factor : 6.008

Figure 20: Real



Powerr and Reactive Power

The active power is the real power consumes by the load. Whereas, the reactive power is the useless power. The active power is the product of the voltage, current and the cosine of the angle between them. Whereas, the reactive power is the product of voltage and current and the sine of the angle between them.

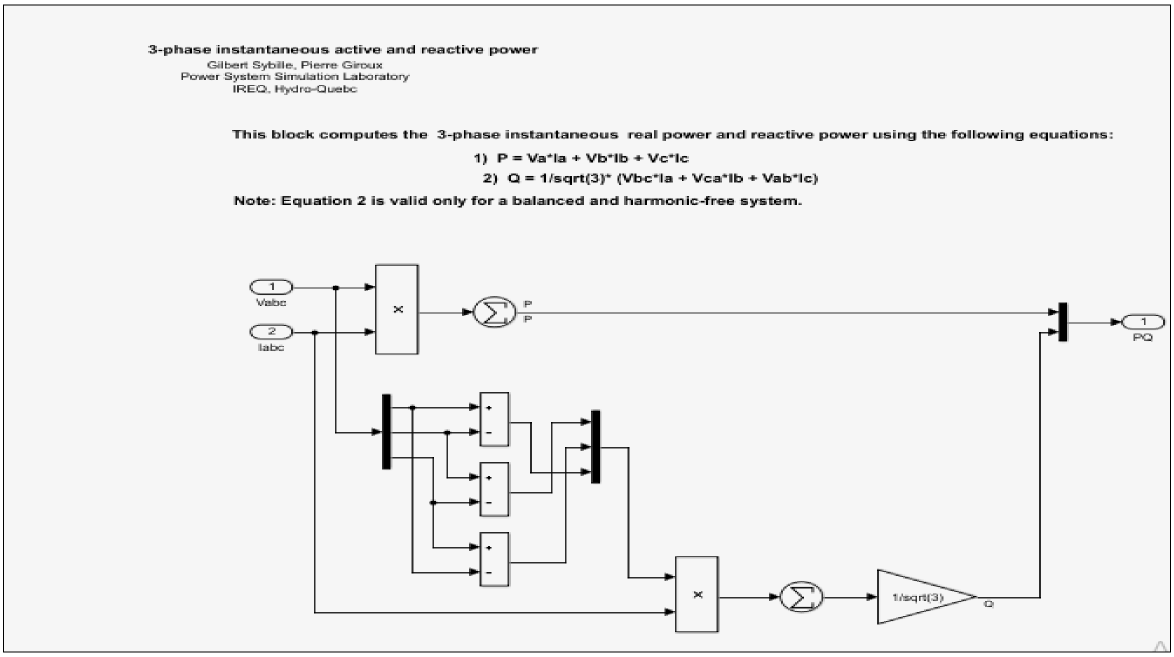


Figure 21: Phase Instantaneous Active and Reactive Power

ISSN : 2455-9679
SJIF Impact Factor : 6.008

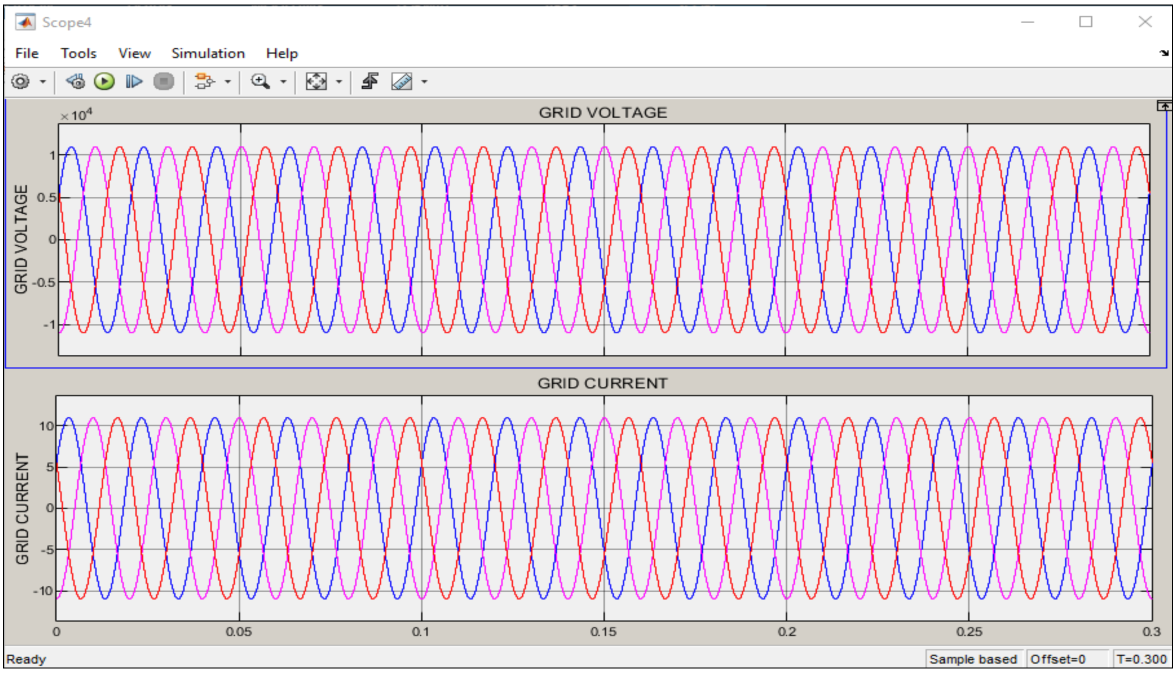


Figure 22: Grid Voltage and Current

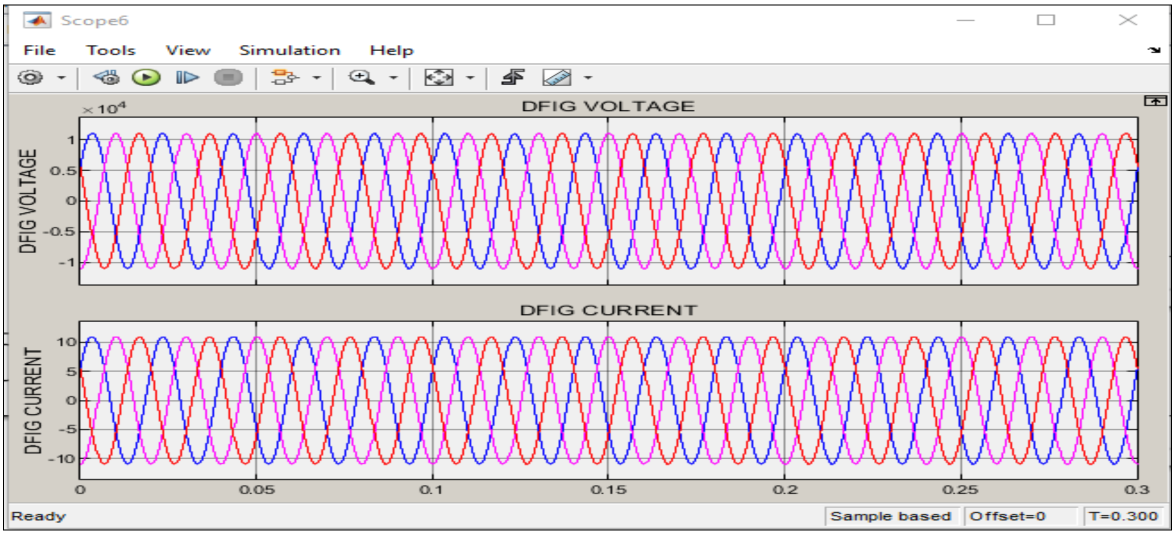


Figure 23: DFIG Voltage and Current

The DFIG consists of a 3 phase wound rotor and a 3 phase wound stator. The rotor is fed with a 3 phase AC signal which induces an ac current in the rotor windings.

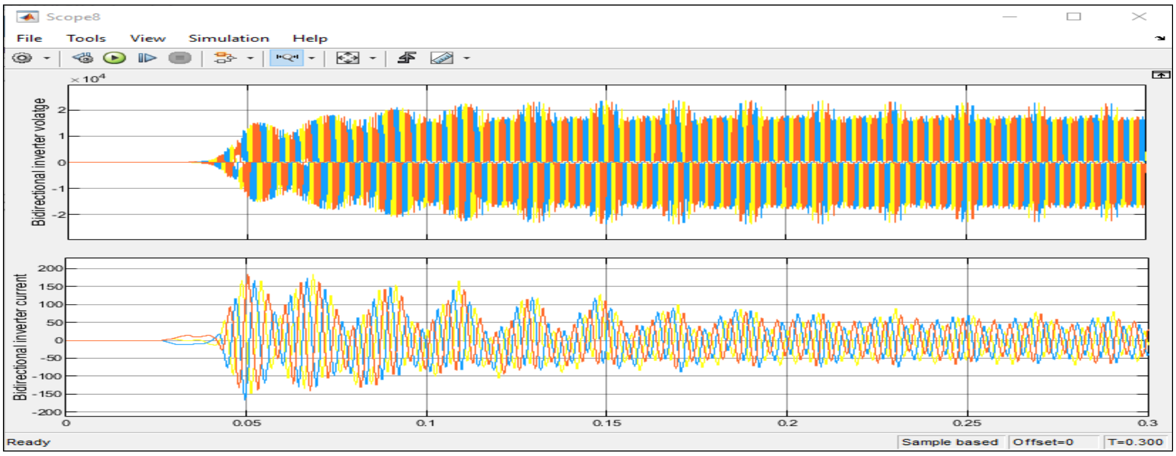


Figure 24: Bidirectional Inverter Current and Voltage

ISSN : 2455-9679
SJIF Impact Factor : 6.008

The bidirectional DC-AC inverter transfers power from the DC stage to the connected AC grid while the DC loading requirement is small. Or, the inverter transfers the power from the connected AC grid to the DC stage if the DC energy is insufficient for the DC loading requirement.

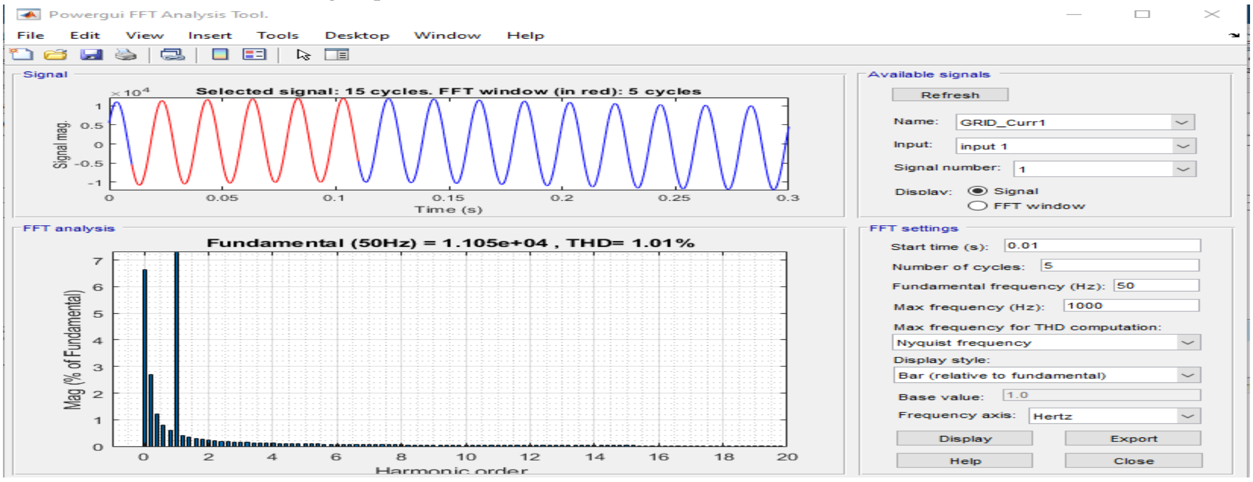


Figure 25 with solar thd

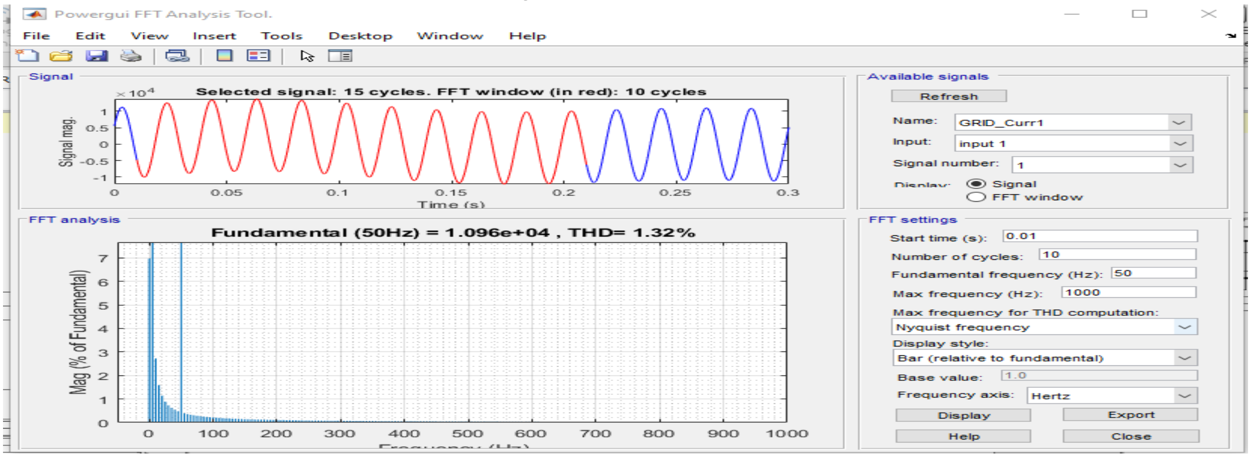


Figure 26 Without solar THD

Table 3 showing the comparison result in between proposed wok and exiting work, solar irradiance and grid power compare with the existing work, in the proposed work grid power showing higher as compare to existing work

Table 4 THD comparison With Solar and without solar

MODEL	THD
With Solar	**1.01**
Without Solar	**1.32**

Table 4 Showing The THD Comparison With And Without Solar, In The Proposed System Two Model Designed As DFIG With Solar And DFIG Without Solar, With Solar THD Showing Better As Compare To Without Solar

.

IV. CONCLUSION

The global energy consumption is increasing and the wind power generation is steadily rising and is being seen as a supplement and an effective alternative to large conventional power generation units. The power generated from wind energy systems needs to be fed into the grid and hence there is a need of an efficient interface between the wind energy systems and the grid. Power electronics serves as interface is necessary not only for the renewable energy source but also for its effects on the power system operation as the wind energy systems serve as an intermittent source of energy. The power electronics technology plays a very important role in the integration of renewable energy sources into the

ISSN : 2455-9679
SJIF Impact Factor : 6.008

electrical grid, and it is widely used and rapidly expanding as these applications become more integrated with the grid systems. The technology used in the early developed wind turbines was based on a squirrel cage induction generator (SCIG) connected directly to the grid. This almost transfers the wind power pulsations to the electrical grid. There was no control of active and reactive powers which are key parameters to control frequency and voltage. This thesis, after conducting extensive literature review, explains how controlled active power, according to the grid requirements can be fed into the system.

REFERENCES

[1] Hossein Gholizadeh;Negar Totonchi;Reza Sharifi Shahrivar;Saeed Mahdizadeh;Ebrahim Afjei;Ali Abbasi Design and Implementation of A Transformerless High Step-Up DC-DC Converter Based on Conventional Boost Converter and Voltage Multiplier Cells 2021 12th Power Electronics, Drive Systems, and Technologies Conference (PEDSTC) Year: 2021 | Conference Paper | Publisher: IEEE
[2] Hiroaki Matsumori;Takashi Kosaka;Kisho Sekido;Kitae Kim;Takashi Egawa;Nobuyuki Matsui Isolated DC-DC Converter utilizing GaN power device for Automotive Application 2019 IEEE Applied Power Electronics Conference and Exposition (APEC)Youssef Moumani, Abdeslam Jabal Laafou, Abdessalam Ait Madi Modeling and Backstepping Control of DFIG used in Wind Enegry Conversion System 2021 7th International Conference on Optimization and Applications (ICOA) Year: 2021 | Conference Paper | Publisher: IEEE DOI: 10.1109/ICOA51614.2021.9442625
[3] Abdeslam Jabal Laafou;Abdessalam Ait Madi;Adnane Addaim Dynamic Control of DFIG used in Wind Power Production, based on PI regulator 2020 IEEE 2nd International Conference on Electronics, Control, Optimization and Computer Science (ICECOCS) Year: 2020 | Conference Paper | Publisher: IEEE DOI: 10.1109/ICECOCS50124.2020.9314563
[4] Jitheesh P Gopalan, Binitha Joseph Mampilly, "A Versatile STATCOM for SSR Mitigation and Dynamic Reactive Power Management in DFIG Based Wind Farm Connected to Series Compensated Line 2020 IEEE International Power and Renewable Energy Conference Year: 2020 | Conference Paper | Publisher: IEEE DOI: 10.1109/IPRECON49514.2020.9315202
[5] Răzvan Beniugă, Oana Beniugă, Dragoç Machidon Assessment of DFIG wind turbine overvoltage protection system for grid stability 2019 8th International Conference on Modern Power Systems (MPS) Year: 2019 | Conference Paper | Publisher: IEEE DOI: 10.1109/MPS.2019.8759781
[6] Jinxin Ouyang;Ting Tang;Jun Yao;Mengyang Li Active Voltage Control for DFIG-Based Wind Farm Integrated Power System by Coordinating Active and Reactive Powers Under Wind Speed Variations IEEE Transactions on Energy Conversion Year: 2019 | Volume: 34, Issue: 3 | Journal Article | Publisher: IEEE
[7] Jin Ma, Dawei Zhao, Liangzhong Yao, Minhui Qian, Koji Yamashita, Lingzhi Zhu Analysis on application of a current-source based DFIG wind generator model CSEE Journal of Power and Energy Systems Year: 2018 | Volume: 4, Issue: 3 | Journal Article | Publisher: CSEE DOI: 10.17775/CSEEJPES.2018.00060
[8] Subinay Vajpayee, Nihar Ranjan Panda, Prasanajit Behera, Sarat Chandra Swain "Implementation of PLL algorithm in DFIG based wind turbine connected to utility grid 2020 Second International Conference on Inventive Research in Computing Applications" (ICIRCA) Year: 2020 | Conference Paper | Publisher: IEEE DOI: 10.1109/ICIRCA48905.2020.9182961
[9] Kamal Ouezgan, Badre Bossoufi, Mohammed Najib Bargach, "DTC Control of DFIG-Generators for Wind Turbines: FPGA Implementation" International Renewable and Sustainable Energy Conference (IRSEC) Year: 2017 | Conference Paper | Publisher: IEEE DOI: 10.1109/IRSEC.2017.8477300
[10] Panneer Selvam Manickam, Prakasam Periasamy Tracking the Maximum Wind Power Point using Neuro-Fuzzy Control with DFIG-BESS for Wind Energy System 2018 Conference on Emerging Devices and Smart Systems (ICEDSS) Year: 2018 | Conference Paper | Publisher: IEEE DOI: 10.1109/ICEDSS.2018.8544358
[11] Xinglong Wang, Song Han, "Modeling of DFIG based wind farm considering temporal and spatial non-uniformity of wind speed in mountainous region and its applicability analysis" 2017 29th Chinese Control And Decision Conference (CCDC) Year: 2017 | Conference Paper | Publisher: IEEE DOI: 10.1109/CCDC.2017.7978389

ISSN : 2455-9679
SJIF Impact Factor : 6.008

[12] Preeti Sonkar, O. P. Rahi, "Study of short-term frequency regulation techniques of DFIG Wind turbine" 2017 IEEE International Conference on Power, Control, Signals and Instrumentation Engineering (ICPCSI) Year: 2017 | Conference Paper | Publisher: IEEE DOI: 10.1109/ICPCSI.2017.8392078

[13] Xie Hua, Xu Hongyuan, Li Na, "Control strategy of DFIG wind turbine in primary frequency regulation" 2018 13th IEEE Conference on Industrial Electronics and Applications (ICIEA) Year: 2018 | Conference Paper | Publisher: IEEE DOI: 10.1109/ICIEA.2018.8397992

[14] Md Aktarujjaman, M. E. Haque, S. Saha, M. Negnevitsky "Impact of DFIG Based Wind Generation on Grid Voltage and Frequency Support" 2020 International Symposium on Power Electronics, Electrical Drives, Automation and Motion (SPEEDAM) Year: 2020 | Conference Paper | Publisher: IEEE DOI: 10.1109/SPEEDAM48782.2020.9161867

[15] Anjali V. Deshpande, V. A. Kulkarni Simplified Model of DFIG in Wind Integrated Power System 2019 3rd International Conference on Computing Methodologies and Communication (ICCMC) Year: 2019 | Conference Paper | Publisher: IEEE DOI: 10.1109/ICCMC.2019.8819670