"SIMULATION ON OPTIMISATION OF POWER QUALITY USING HYBRID POWER SYSTEM"

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Abstract - *The trend of generating electrical power through renewable energy sources is increasing day by day to reduce the burden on fossil fuels. Solar photovoltaic is one of the fastest growing renewable energy sources because of its merits such as abundancy in nature, ease of installation, and its flexible and modular nature. The energy output of the power systems can be made more reliable when such renewable energy resources are combined with conventional energy generating systems. In this project a hybrid system comprising a hydro system is used in combination with a solar photovoltaic system to ensure the continuity in power supply. A power quality compensation scheme is used to overcome the power quality issues due voltage sags caused by three phase faults. Thus power generation is made more reliable and power systems are made more efficient.*

1. INTRODUCTION

In today"s climate of growing energy needs and increasing environmental concern, alternatives to the use of non-renewable and polluting fossil fuels have to be investigated. One such alternative is solar energy. Other reasons include advantages like abundant availability in nature, eco-friendly and recyclable. With solar power, we can save electricity and decrease carbon footprint. The system is also easy to maintain as there are no moving parts. It is at least 20-30% cheaper than the prevailing grid tariffs for most commercial and industrial consumers in India. Solar power is certainly much more beneficial than other sources of renewable energy.

Typical photovoltaic cell efficiency is about 15%, which means it can convert 1/6 of solar energy into electricity. Photovoltaic systems produce no noise, there are no moving parts and they do not emit pollutants into the environment. Taking into account the energy consumed in the production of photovoltaic cells, they produce several tens of times less carbon dioxide per unit in relation to the energy produced from fossil fuel technologies.

The contribution of solar energy to the grid during periods of peak demand is significant since, reducing demand on the grid through the addition of clean solar energy can help reduce the likelihood of brownouts and rolling blackouts when temperature rise. An increase in solar energy produced during peak periods equals decreased demand on the grid, and decreased demand on the grid means lower costs of energy during peak periods. The reality is that solar has the potential to bring the price of peak energy down for ratepayers across the board.

1.1 LITERATURE REVIEW

1. Young –Kwan choi (2013), Floating PV cells

This author presents the floating photovoltaic system is a new concept energy technology to meet needs of our time. The system integrates existing land based photovoltaic technology with a newly developed floating photovoltaic technology. By this way the uninterrupted power can be feed to the grid/load.

2. Prof. Rakshith P (2019), Voltage balancing technique

This author presents the voltage balancing technique when the voltage imbalance occurs in the grid along with the renewable energy sources. Because the supplying the constant/ balanced voltage to the load is also one of the major objectives of the power grid.

3. Onur KIRCIOQLU, Murat UNLU, Sabri CAMUR(2014), SEPIC Converter

These authors presents conversion of DC-DC voltage is also the important when the DC voltage is frequently changing in magnitude, so they have used the SEPIC converters to boost the voltage to the magnitude we required.

1.2 ORGANIZATION OF THE REPORT

This report contains 4 chapters

- Chapter 1 contains introduction, literature review & organization of the report
- Chapter 2 contains methodology
- Chapter 3 contains hardware components & software components
- Chapter 4 contains applications ,advantages and disadvantages

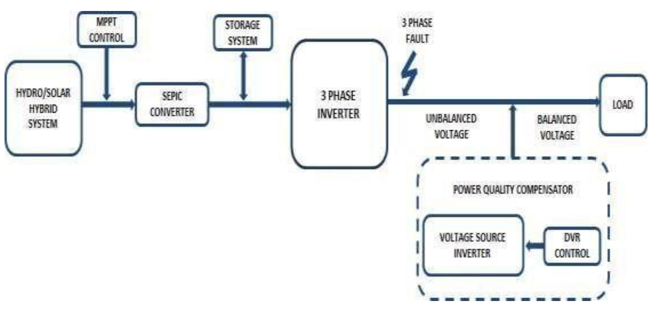
2. METHODOLOGY

Hybrid power is combinations between different technologies to produce power. Power Crisis is one of the top most problems in recent years. Power is usually generated using non renewable energy sources such as steam, oil, petroleum gases, nuclear, etc., for producing of such power the available raw material are not more than enough and investment cost become great issues. To run over the above issues, accumulating green energy will provide a better result. Since each green energy system is eco-friendly it also has its certain demerits in power generation and hence connecting more than one unique system together will facilities continuous power generation and it will not spoil the atmosphere.

Specifically in our project, two major energy resources like solar, wind and hydro areused for generating uninterrupted power. Each system is designed with precise criteria and connects to form a consistent energy resource. Solar and hydro energy systems are selected for the implementation. Using

MATLAB/SIMULINK simulation has been done.

2.1 BLOCK DIAGRAM



Fig–1: Block diagram of Power quality retention and output power optimization in hybrid hydro/PV system.

3. HYBRID ENERGY SYSTEM

Hybrid power is combinations between different technologies to produce power. Power Crisis is one of the top most problems in recent years. Power is usually generated using non renewable energy sources such as steam, oil, petroleum gases, nuclear, etc., for producing of such power the available raw material are not more than enough and investment cost become great issues. To run over the above issues, accumulating green energy will provide a better result. Since each green energy system is eco-friendly it also has its certain demerits in power generation and hence connecting more than one unique system together will facilities continuous power generation and it will not spoil the atmosphere. Specifically in our project, two major energy resources like solar, wind and hydro are used for generating uninterrupted power. Each system is designed with precise criteria and connects to form a consistent energy resource. Solar and hydro energy systems are selected for the implementation. Using MATLAB/SIMULINK simulation has been done.

3.1 PHOTOVOLTAIC ENERGY SYSTEM

The photoelectric conversion in the PV junction. PV junction (diode) is a boundary between two differently doped semiconductor layers; one is a Ptype layer (excess holes), and the second one is an N_ type (excess electrons). At the boundary between the P and the N area, there is a spontaneous electric field, which affects the generated electrons and holes and determines the direction of the current.

To obtain the energy by the photoelectric effect, there shall be a directed motion of photoelectrons, i.e. electricity. All charged particles, photoelectrons also, move in a directed motion under the influence of electric field. The electric field in the material itself is located in semiconductors, precisely in the impoverished area of PV junction (diode). It was pointed out for the semiconductors that, along with the free electrons in them, there are cavities as charge

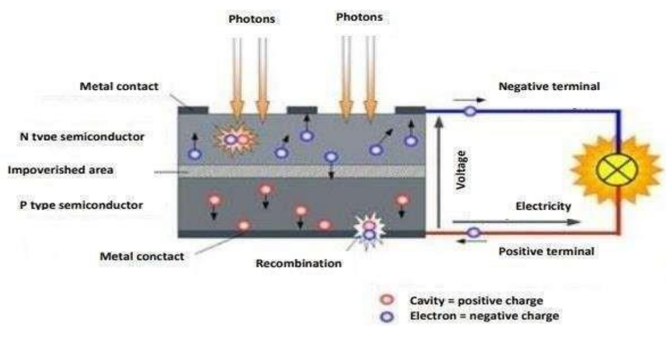


Fig-2: Function of PV Cell

Carriers, which are a sort of by-product in the emergence of free electrons. Cavities occurs whenever the valence electron turns into a free electron, and this process is called the generation, while the reverse process, when the free electron fills the empty spaces a cavity, is called recombination. If the electron cavity pairs occur away from the impoverished areas it is possible to recombine before they are separated by the electric field.

Photoelectrons and cavities in semiconductors are accumulated at opposite ends, thereby creating an electromotive force. If a consuming device is connected to such a system, the current will flow and we will get electricity.

In this way, solar cells produce a voltage around 0.5 - 0.7 V, with a current density of about several tens of mA/cm^2 depending on the solar radiation power as well as on the radiation spectrum.

3.2 HYDROELECTRIC ENERGY SYSTEM

In hydropower plant potential and kinetic energy of the water is used to rotate the turbine and hence generator to generate electricity.

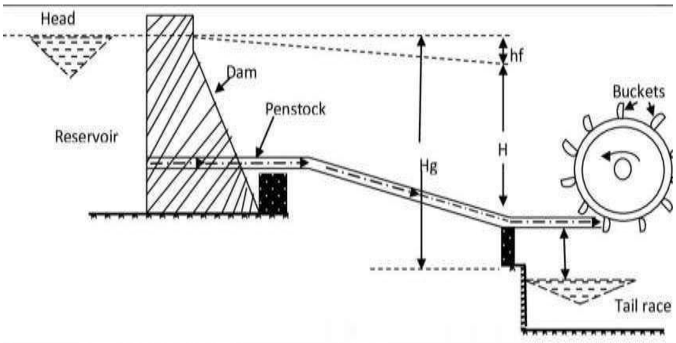


Fig-3: Basic Layout Diagram of the Hydroelectric Power Plant.

CONSTRUCTION & WORKING OF HYDROELECTRIC

POWER PLANT

Following are some of the main components of the hydroelectric power plant.

1. Reservoir: water harvested from the catchment area is stored in the reservoir which is then used to generate the electricity.

2. Dam: it is made in the path of the river to make the reservoir to hold the rain water.

3. Pillways: Spillways are made to make the dam safe. When level of water is exceeds some defined point, it will discharge through these spillways.

4. Forebay: when there is sudden change in the turbine load, in such cases there is need of temporary storage of water. This temporary storage of water near turbine is called as forebay.

5. Surge tank: surge tank is built in between dam and the valve house. It is used to take care of the system load fluctuations.

6. Penstock: it is water pipeline carrying water from dam to turbine.

7. Prime mover or turbine: it is the main part of the power station. It is coupled with the generator. Turbine is rotated by the flow of water. As it is coupled with the generator, generator also rotates which produces electricity.

8. Powerhouse: it consists of turbine, alternator and electrical equipment.

9. Tail races: outlet water of the turbine is discharged to the river trough tail races.

3.3 IC ALGORITHM

Algorithm steps

Step 1: It will check for the inputs.

Step 2: It will check the difference between instantaneous value and next interval value.

Step 3: It will verify the /=0, if it is yes algorithm will stop this indicates system si operating at maximum point hence maximum power will obtained.

Step 4: If it fails it will checks for />0 then it will increase the Vref value, if not it wil decrease the Vref value.

Step 5: Algorithm will stop and error will be rectified.

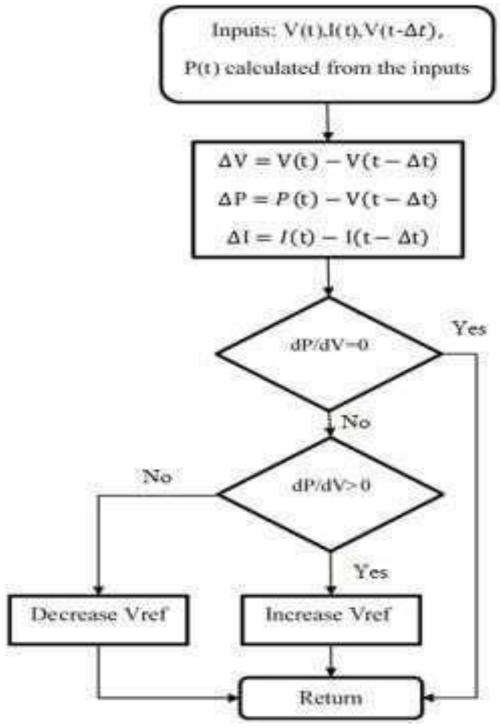


Fig-4 : Flowchart of Incremental Conductance Algorithm

3.4 CONSTRUCTION OF DVR

Power circuit and the control circuit are the 2 main parts of the DVR. There are various critical parameters of control signals such as magnitude, phase shift, frequency etc. which are injected by DVR. These parameters are derived by the control circuit. This injected voltage is generated by the switches in the power circuit based on the control signals. Furthermore the basic structure of DVR is described by the power circuit and is discussed in this section. The 5 main important parts of power circuit, their function and requirements are discussed ahead.

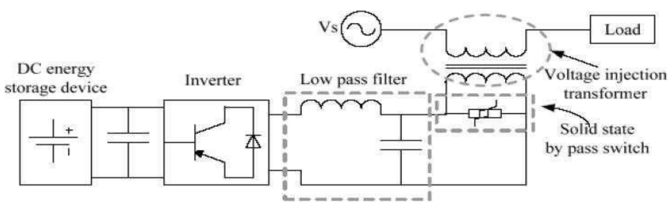


Fig-5: DVR Power Circuit

3.5 ENERGY STORAGE UNIT

Various devices such as Flywheels, Lead acid batteries, Superconducting Magnetic energy storage (SMES) and Super-Capacitors can be used as energy storage devices. The main function of these energy storage units is to provide the desired real power during voltage sag. The amount of active power generated by the energy storage device is a key factor, as it decides the compensation ability of DVR. Among all others, lead batteries are popular because of their high response during charging and discharging But the discharge rate is dependent on the chemical reaction rate of the battery so that the available energy inside the battery is determined by its discharge rate.

3.6 DVR OPERATING MODES

During a voltage sag/swell on the line

The difference between the pre sag voltage and the sag voltage is injected by the DVR by supplying the real power from the energy storage element and the reactive power. The DVR injects the difference between the pre-sag and the sag voltage, by supplying the real power requirement from the energy storage device together with the reactive power. Due to the ratings of DC energy storage and the voltage injection transformer ratio the maximum capability of DVR is limited. The magnitude of the injected voltage can be controlled individually in the case of three single-phase DVRs. With the network voltages the injected voltages are made synchronized (i.e. same frequency and the phase angle)

During the normal operation

During the normal operation as there is no sag, DVR will not supply any voltage to the load. It will be in a standby mode or it operates in the self-charging mode if the energy storage device is fully charged. The energy storage device can be charged either from the power supply itself or from a different source.

During a short circuit or fault in the downstream of the distribution line

In this case we have seen before that a bypass switch (crossbar switch) will be activated and it will bypass the inverter circuit in order to protect the electronic components of the inverter .

3.7 SIMULATION MODEL

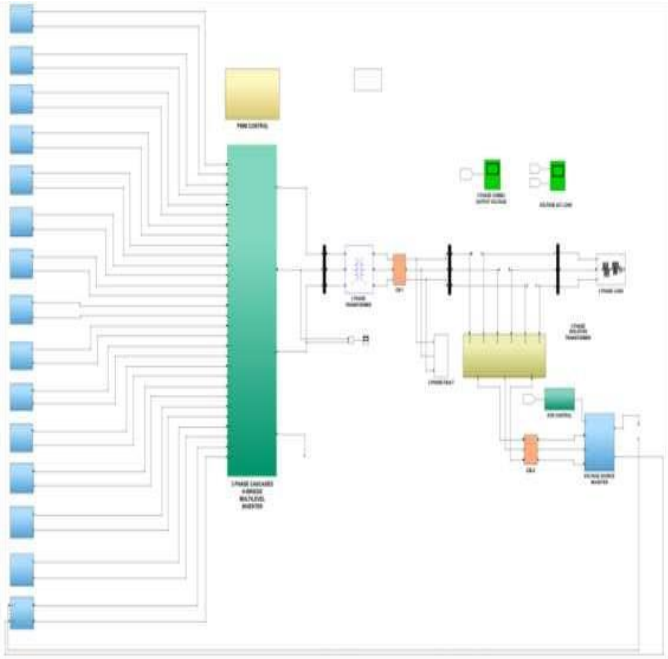


Fig-5: Simulink Model of Hybrid Hydro/PV System Connected to a 3-phase load.

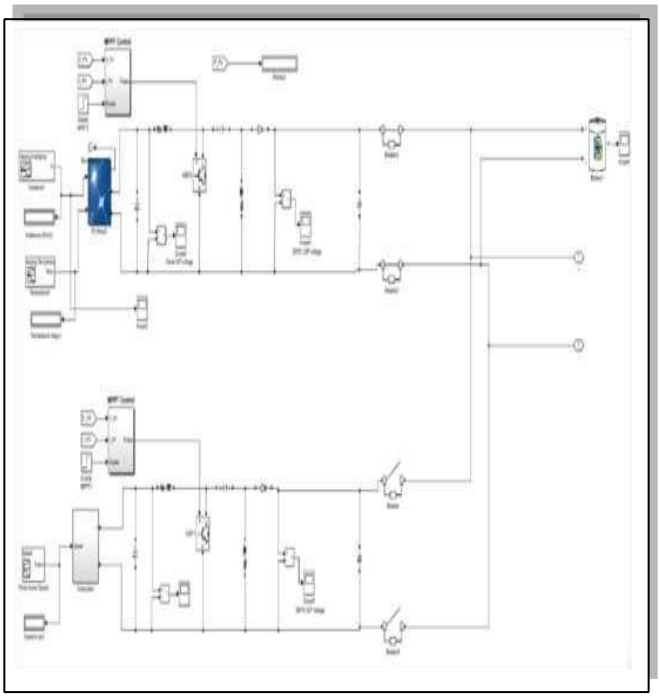


Fig-6: Interconnection of Hydro/PV Hybrid system **Demonstration**

1. Run this simulation model for 1 second and observe the following sequence of events on scope.

2. At t=0 sec MPPT is enabled. The MPPT regulator starts regulating PV voltage by varying duty cycle in order to extract maximum power up to t=0.5 sec.

3. From t=0 sec to t=0.5 sec, PV array starts generating voltage and this voltage will supplied to load through a SEPIC converter and Cascaded H bridge inverter.

4. From t=0.5 sec hydro system MPPT is enabled and its starts regulating a hydro turbine speed by varying duty cycle using Incremental conductance algorithm in order to extract maximum power up to t=1 sec.

5. From t=0.5 sec to t=1 sec, hydro system starts generating voltage same will be given to SEPIC converter then supplied to load through a inverter.

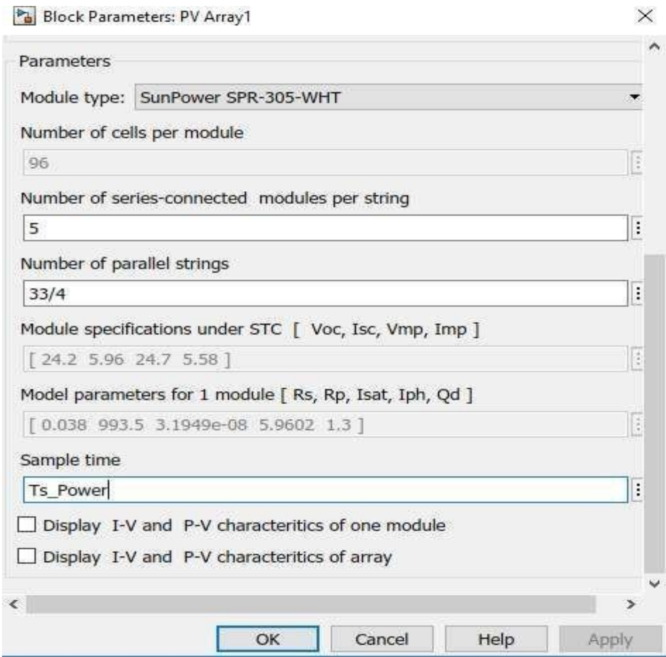
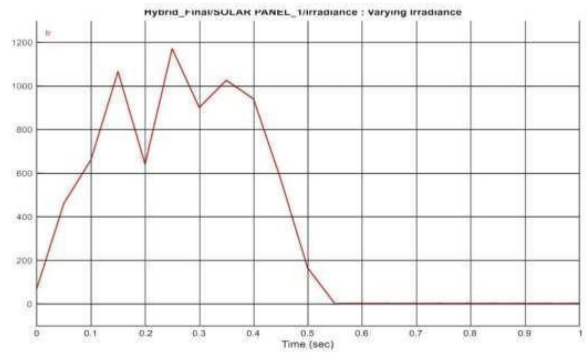
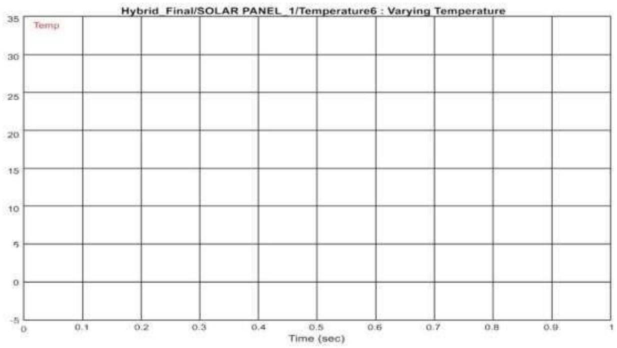
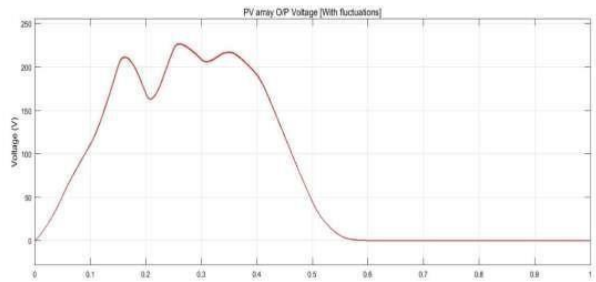


Fig-7: Functional Block of PV Array







THREE-PHASE, 11-LEVEL, CASCADED H-BRIDG MULTI LEVEL INVERTER

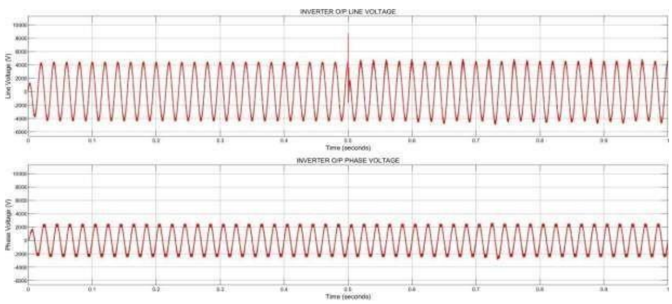


Fig-8: Inverter Output Voltage both Line and Phase

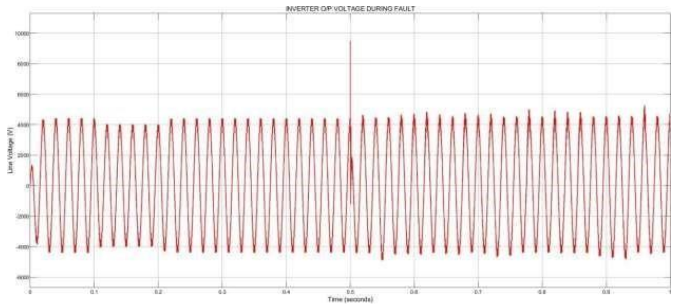


Fig-9: Inverter Output Voltage during Fault

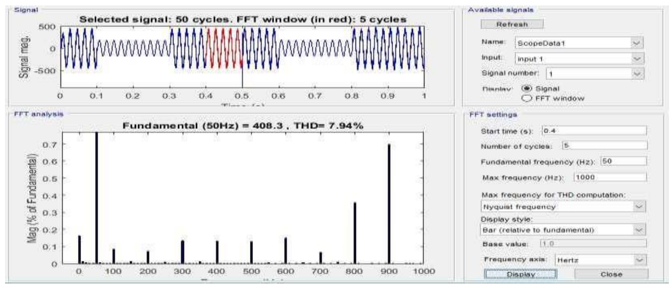


Fig-10: FFT Analysis of Output Voltage without DVR

The FFT analysis carried on the output voltage shows the THD is 7.94%. The harmonics distortion has to be reduced below 5% as per the IEEE standards.

3.8 DYNAMIC VOLTAGE RESTORER

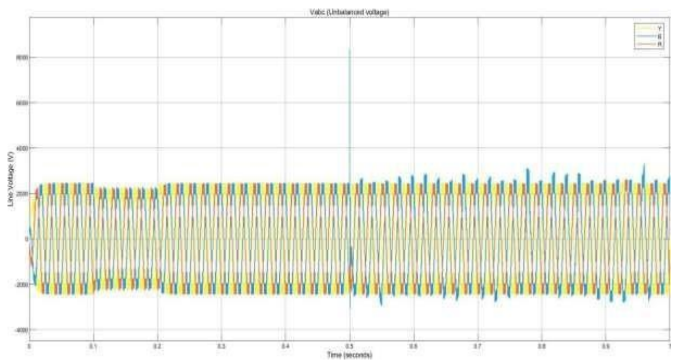


Fig-11: Unbalanced (Fault) Line Voltage without DVR

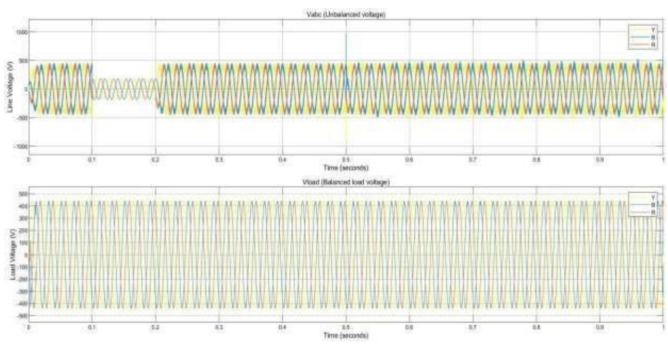


Fig-12: Balanced Load Voltage with DVR

The Figure 8.6.2 shows the voltages during fault and the balance in voltage obtained with the employment of DVR in the system. An artificial three phase fault is created in the system from 0.1-0.2seconds. The sag in the in the load voltage that leads to power quality issues can be seen. The balance obtained in the load voltage is also shown the above Figure 7.6.2. The DVR improves both the waveform and magnitude of the unbalanced voltage waveform, thereby improving the power quality. Also, we can see in the Figure 8.6.3 the incorporation of DVR has reduced the THD to 1.06% which is below 5%.

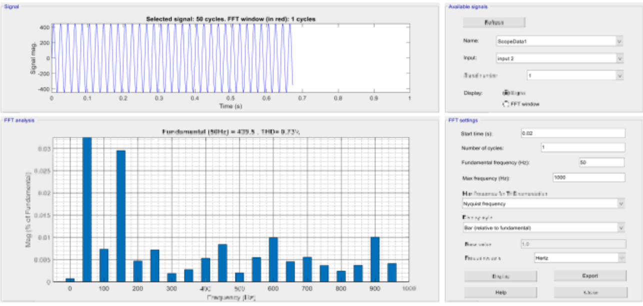
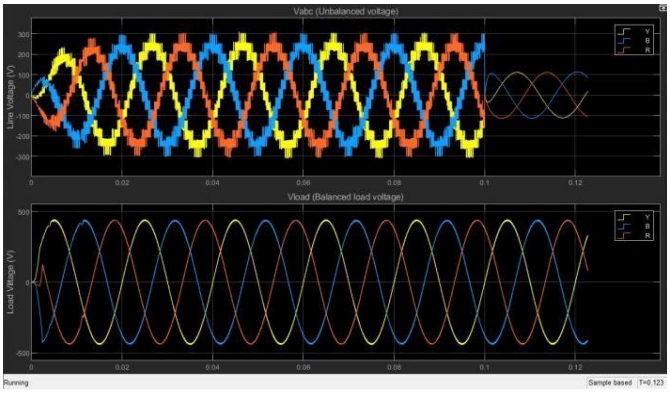
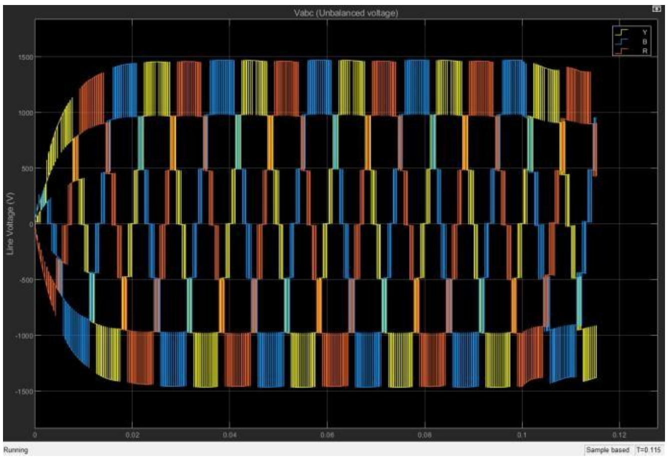
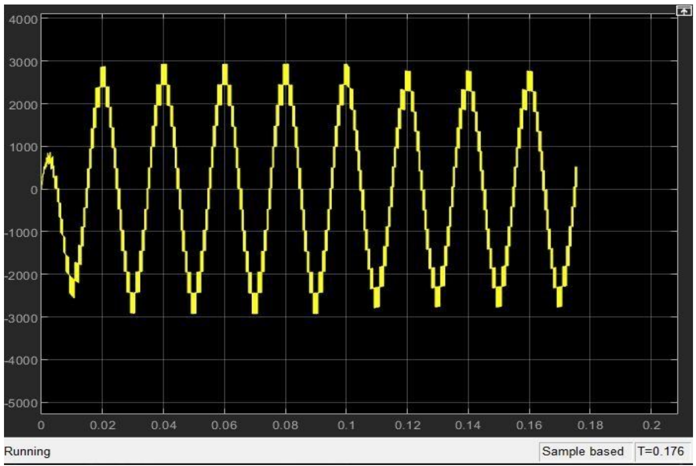


Fig-12: FFT Analysis Carried On Output Voltage with DVR

4. OUTPUT







5. CONCLUSIONS

The hybrid model designed mainly focuses on the output optimization and power quality retention. The system designed is capable of maintaining its power at maximum level irrespective of the environmental changes. The PV system operates at maximum power point even though there are fluctuations in temperature and irradiation levels also; the hydro system produces maximum power despite the varying prime speed. Incorporation of the incremental conductance algorithm of maximum power point tracking is used. The output characteristics of the Hybrid hydro/PV system are simulated considering the shading effect, varying temperature and speed. SEPIC converter is used to boost the tracked voltage and thus along with MPPT control its helps in maintaining a constant voltage. The output of CHB inverter is stepped down to 440V AC. The disturbances to the power quality caused by the faults leading to voltage sags are addressed by a power quality compensation scheme. The DVR control used in the model is capable of maintaining the desired voltage profile of the system thus helps in controlling the power quality of the system. The harmonics distortions present in the load voltage waveforms were observed using FFT analysis tool in MATLAB/Simulink. The total harmonic distortion is reduced to 1.06% from 7.94% with the incorporation of DVR. The functionality of the entire proposed model has been demonstrated by simulation, and the results obt IRJET sample template format ,Conclusion content comes here. Conclusion content comes here Conclusion content comes here Conclusion content comes here Conclusion content comes here Conclusion content comes here Conclusion content comes here Conclusion content comes here Conclusion content comes here Conclusion content comes here Conclusion content comes here Conclusion content comes here Conclusion content comes here .

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