

# Designing of Grid Connected Solar Wind Hybrid System using Nine Level Inverter

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**Abstract**— Many multilevel inverter topologies have been proposed during the last three decades. Modern research has engaged novel inverter topologies and unique modulation schemes. Three different major multilevel inverter structures have been reported in the literature: cascaded H-bridges inverter with separate DC sources, diode clamped (neutral clamped) and flying capacitors (capacitor clamped). Multilevel inverters are utilized generally in the regular applications due to the high voltage capacity and it delivers the multilevel with low composition with least concern in the exchanging gadgets. Contrasted with the traditional single scaffold inverter the multilevel inverter lessens the music due to the multi exchanging. The multilevel inverter produces distinctive voltage levels by shifting the exchanging grouping of the inverter. As the conservative energy sources are demolishing, in the middle of consequent mount in cost, solar and wind energy offers a major substitute resource which is free from pollution also. This paper proposes an idea of using hybrid energy system with the multilevel inverter system.

**Keywords:** DC/DC Boost Converter, Nine Level Inverter, Multilevel Inverter, Hybrid System

## I. INTRODUCTION

In many rural areas uninterrupted electricity is not accessible from grid. Mostly the grid gets power from the hydro power station and from thermal power station too. As the conservative energy sources are demolishing, in the middle of consequent mount in cost, solar and wind energy offers a major substitute resource which is free from pollution also. The renewable energy resources are very profitable and they will not cause any detrimental effects on the surroundings. With the latest researches, results the expenditure of photovoltaic cells are likely to go down in future. Each cell having 0.7V and that are allied in series or parallel and form solar array. The PV power generation is a budding modern trend owing to its various advantages resembling inexpensive, ecological responsive power generation.

This work manages the multilevel converters control procedure for photovoltaic framework coordinated in dispersion matrices. The proposed control plan guarantees the infusion of the produced power in the conveyance network with quick element reaction, while giving an extra dynamic force sifting ability giving the required consonant and responsive streams to be considered. The control plan is approved by method for reenactments with a course converter which interfaces to a dispersion network. Additionally, for DC joint voltage control, it is required that balances out the voltage at the inverter data to protect a ceaseless stream of vitality trade between the matrix and the PV framework. Similarly, a LC channel is important to channel the yield current and voltage from the sounds and to shield the network from their ruinous impact. At long last, this work presents

demonstration of the framework joined photovoltaic era framework parts, in Simulink/Mat lab programming. The results displayed to approve the parts models and the picked control plans. Following are some problems which are sorted in this project:

- 1) The study has been mainly confined by using PV battery based single input transformer.
- 2) Study using hybrid system i.e. photovoltaic along with wind battery system has not been much explored.
- 3) Study based on multilevel inverter transformer coupled with dc-dc converter has not been discussed much.
- 4) Three phase system from a hybrid system including photovoltaic cells and wind energy system. Through which the load will be drawn based on the nine level inverter. Following are objective of this paper: has unbalanced loading which causes voltage fluctuations.
- 5) The three phase system is a complex system which requires symmetrical components for analysis and operation.
- 6) The phase sequence is required to be remembered while making connections.
- 7) Uninterrupted power supply is hard to provide using any one of the renewable energy source.

The aim of this paper is to develop a system that will be able to draw energy

- 1) Energy from hybrid system is extracted.
- 2) The extracted energy will be stored in battery and given to the bidirectional dc to dc converter coupled with multilevel inverter.
- 3) Load will be drawn from it.

## II. METHODOLOGY

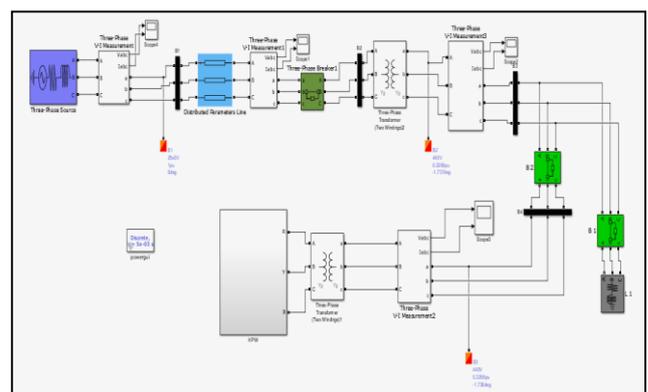


Fig. 2.1: Simulink model of grid connection with hybrid nine level inverter system

### A. Hybrid System:

Hybrid energy system is the combination of two energy sources for giving power to the load. In other word it can be defined as “Energy system which is fabricated or designed to extract power by using two energy sources is called as the

hybrid energy system.” Hybrid energy system has good reliability, efficiency, less emission, and lower cost. In this proposed system solar and wind power is used for generating power. Solar and wind has good advantages than other than any other non-conventional energy sources. Both the energy sources have greater availability in all areas. It needs lower cost. There is no need to find special location to install this system.

1) *Solar panel:*

Solar panel is use to convert solar radiation to the electrical energy. The physical of PV cell is very similar to that of the classical diode with a PN junction formed by semiconductor material. When the junction absorbs light, the energy of absorbed photon is transferred to the electron proton system of the material, creating charge carriers that are separated at the junction. The charge carriers in the junction region create a potential gradient, get accelerated under the electric field, and circulate as current through an external circuit. Solar array or panel is a group of a several modules electrically connected in series parallel combination to generate the required current and voltage. Solar panels are the medium to convert solar power into the electrical power.

2) *Wind Turbine:*

Wind turbine is that system which extracts energy from wind by rotation of the blades of the wind turbine. Basically wind turbine has two types one is vertical and another is horizontal. As the wind speed increases power generation is also increases. The power generated from wind is not continuous its fluctuating. For obtain the non-fluctuating power we have to store in battery and then provide it to the load.

3) *Charge Controller:*

Charge controller has basic function is that it control the source which is to be active or inactive. It simultaneously charge battery and also gives power to the load. The controller has over-charge protection, short-circuit protection, pole confusion protection and automatic dump load function. It also the function is that it should vary the power as per the load demand. It add the both the power so that the load demand can fulfil. And when power is not generating it should extract power from battery and give it to the load.

4) *Battery Bank:*

We have to choose battery bank size per the load requirement so that it should fulfill the requirement of load for calculating the battery bank size we need to find following data: Find total daily use in watt-hour (Wh). And to find total back up time of the battery for increase in battery bank size we need to connect cell in series so that we can get the larger battery bank size.

5) *Inverter:*

We have to choose greater rating inverter than the desired rating .The pure sine wave inverter is recommended in order to prolong the lifespan of the inverter. Inverter is need to convert DC power into AC power. As our load working on the AC supply so we need to convert DC power. The input voltage Output voltage and frequency, and overall power handling depends on the design of the specific device or the circuitry. The inverter does not produce any power. The power is provided by the DC source.

B. *Multilevel Inverter:*

Multilevel inverters are significantly different from the ordinary inverter where only two levels are generated. The semiconductor devices are not connected in series to for one single high-voltage switch. In which each group of devices contribute to a step in the output voltage waveform. The steps are increased to obtain an almost sinusoidal waveform. The number of switches involved is increased for every level increment. The term multilevel began with the three-level converter. Subsequently, several multilevel converter topologies have been developed. However, the elementary concept of a multilevel converter to achieve higher power is to use a series of power semiconductor switches with several lower voltage dc sources to perform the power conversion by synthesizing a staircase voltage waveform. Capacitors, batteries, and renewable energy voltage sources can be used as the multiple dc voltage sources. The commutation of the power switches aggregate these multiple dc sources in order to achieve high voltage at the output; however, the rated voltage of the power semiconductor switches depends only upon the rating of the dc voltage sources to which they are connected.

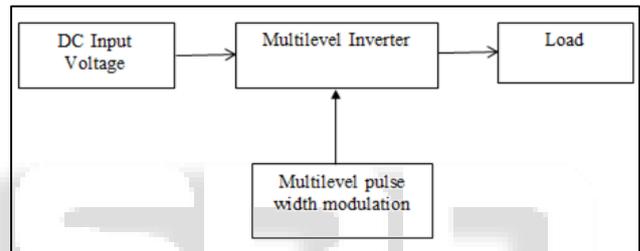


Fig. 2.2: Block diagram of the general multilevel inverter

C. *Nine Level Inverter*

The proposed inverter comprises of fundamental H-connect inverter alongside three bidirectional switches, and a four capacitor. This changed topology utilizes sun based power rather than DC voltage and which utilizes fewer switches and voltage sources. The proposed inverter can be broke down for various load are R, RL and RLC. The inverter utilizes operation as clarified in nine exchanging states framed by sine PWM system.

V0	S1	S2	S3	S4	S5	S6	S7
Vdc	1	0	0	1	0	0	0
3Vdc/4	0	0	0	1	1	0	0
Vdc/2	0	0	0	1	0	1	0
Vdc/4	0	0	0	1	0	0	1
0	1	0	1	1	0	0	0
0	0	1	0	0	0	0	0
(-)Vdc/4	0	1	0	0	1	0	0
(-)Vdc/2	0	1	0	0	0	1	0
(-)3Vdc/4	0	1	0	0	0	0	1
(-)Vdc	0	1	1	0	0	0	0

Table 2.1: Switching states of proposed inverter

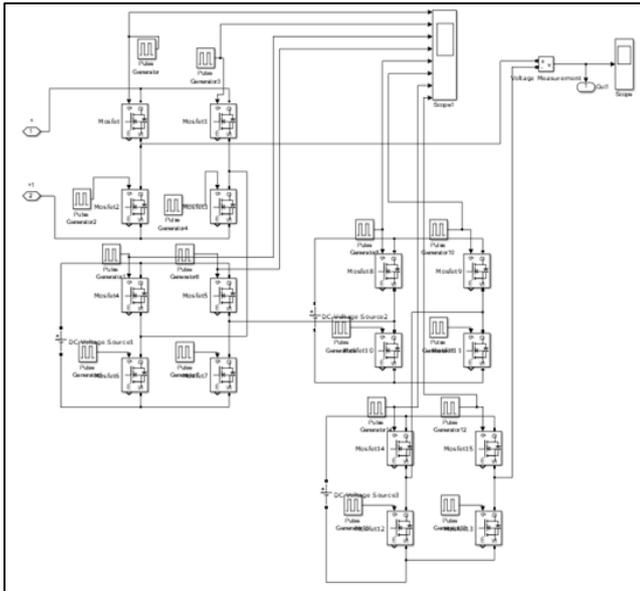


Fig. 2.3: Nine level inverter

1) Pulse width modulation (PWM):

or pulse-duration modulation (PDM), is a method of reducing the average power delivered by an electrical signal, by effectively chopping it up into discrete parts. The average value of voltage (and current) fed to the load is controlled by turning the switch between supply and load on and off at a fast rate. The longer the switch is on compared to the off periods, the higher the total power supplied to the load. Along with MPPT maximum power point tracking, it is one of the primary methods of reducing the output of solar panels to that which can be utilized by a battery.<sup>[1]</sup> PWM is particularly suited for running inertial loads such as motors, which are not as easily affected by this discrete switching. Because they have inertia they react slower. The PWM switching frequency has to be high enough not to affect the load, which is to say that the resultant waveform perceived by the load must be as smooth as possible.

III. RESULT

Designing of hybrid solar wind system is done using MATLAB simulation. In this work in order to convert DC into AC nine level inverter is used. By using higher level of inverter switching losses are reduced and the output obtained is in staircase form which is in nine levels and hence it has less distortion and almost pure sinusoidal waveform can be extracted.

The wind turbine is designed considering a wind speed of 15m/sec. And the solar system with an irradiance of 1000W/m<sup>2</sup>. As the two sources are needed to be hybridized, the voltage level must be same. After getting the same voltage profile this hybrid system is connected to boost converter to get constant DC which is converted into AC using 9 level inverter to get three phase output. The voltage and current drawn from hybrid system is drawn from hybrid system is about 250V and 400 A.

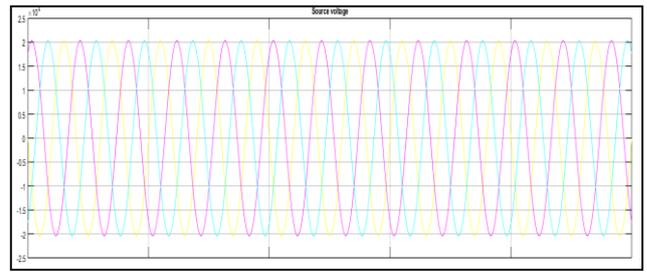


Fig. 3.1: Three phase source Voltage (V) vs Time (sec) plot

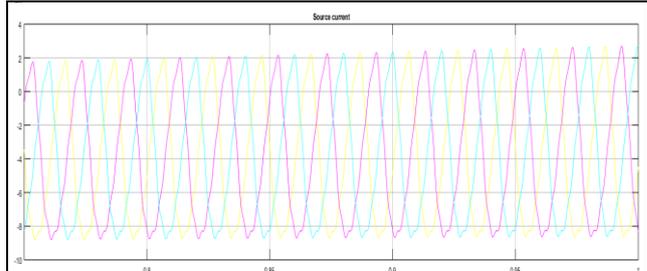


Fig. 3.2: Three phase source Current (A) vs Time (sec) plot

The figures 3.1 and 3.2 show the three phase grid supply voltage and current respectively fed to the system.

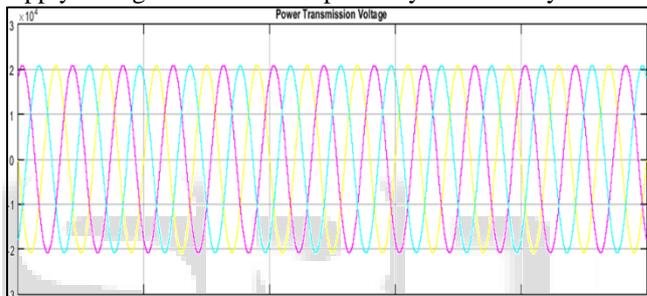


Fig. 3.3: Three phase transmission line Voltage (V) vs Time (sec)

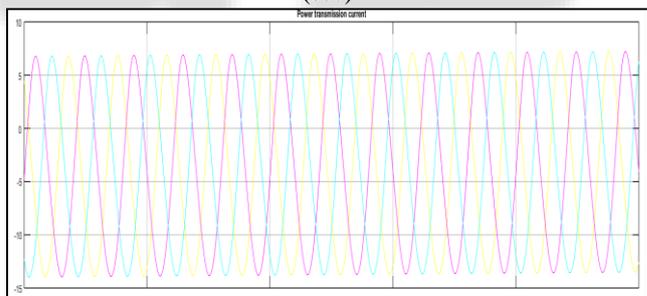


Fig. 3.4: Three phase transmission line Current(A) vs Time (sec)

Figure 3.3 and 3.4 shows line voltage and current after distributed line parameters(R,L,C) are introduced in the line.

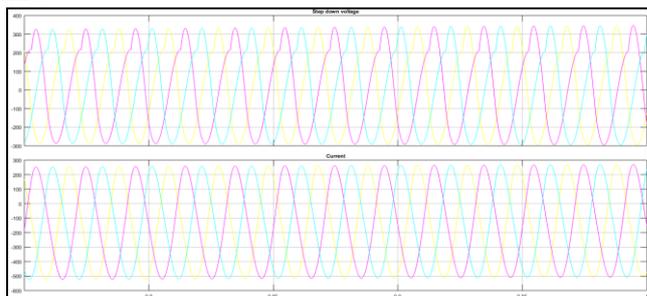


Fig. 3.5: Three phase step down transformer output Voltage (V) and Current (A) vs Time (sec) plot

Figure 3.5 shows the value of voltage and current after step down transformer i.e 300V and 200A

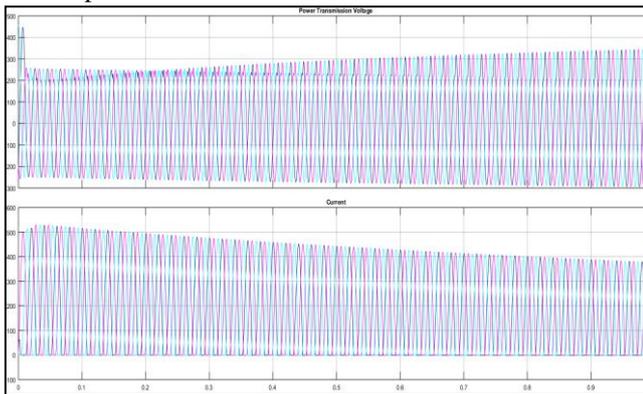


Fig. 3.6: Hybrid system Voltage (V) and Current (A) vs Time (sec) plot

Figure 3.6 shows the output voltage and current of hybrid system which is about 250V and 400A.

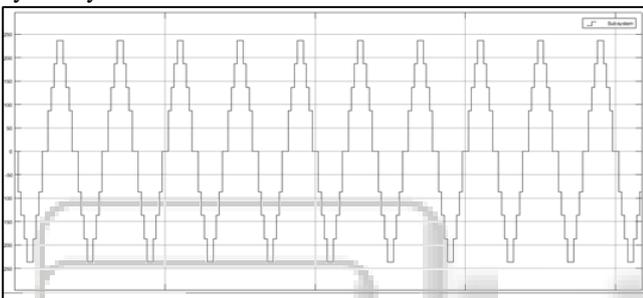


Fig. 3.7: Nine level inverter output

Figure 3.7 exhibits the output waveform of a 9-level inverter. The waveform of output voltage becomes more likely to be sinusoidal (while tracing) as the voltage level getting higher. Hence, the graph become smoother as the voltage level increased. The amplitude of voltage is increased as the level of MLI increases.

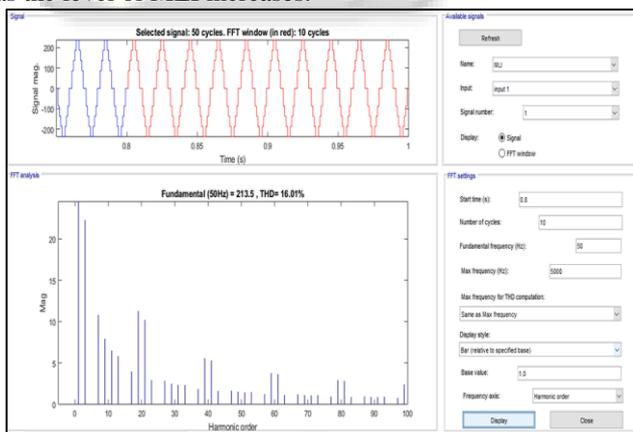


Fig. 3.8: FFT analysis of nine level inverter

Figure 3.8 shows the THD value of nine level inverter which comes to 16.01% using FFT analysis.

Level	Percentage of THD Content (%)
3	51.96
5	27.20
7	18.24
9	16.01

Table 3.1: % THD of MLI

Above table shows that the value of THD is found to be reduced as the number of voltage level of MLI is

increased. [30]. Hence the nine level inverter has least value of THD as compared to lower levels of MLI. Therefore it will give more sinusoidal output waveform than the lower levels MLIs.

#### IV. CONCLUSION

Hybrid power generation system is good and effective solution for power generation than conventional energy resources. It has greater efficiency. It can provide to remote places where government is unable to reach. So that the power can be utilize where it generated so that it will reduce the transmission losses and cost. Cost reduction can be done by increasing the production of the equipment. People should motivate to use the non-conventional energy resources. It is highly safe for the environment as it doesn't produce any emission and harmful waste product like conventional energy resources. It is cost effective solution for generation. It only need initial investment. It has also long life span. Overall it is good, reliable and affordable solution for electricity generation. Multilevel inverter is preferred for the proposed system, since it increases the number of output voltage levels. And hence the Total Harmonic Distortion is also reduced. Also by using higher level of inverter i.e 9 level inverter it is easy to trace pure sinusoidal wave.

#### V. FUTURE SCOPE

Neural network can be applied in the system to control the switching of solar and wind system individually. The SCADA system can be used to store the historical sun and wind profile of any geographical location and analyses the power demand of that place. Based on this proper load scheduling can be done.

The optimal placement of FACTS controller devices may be used for better controlling in hybrid system.

Multilevel inverters are finding increased application in industrial environment with greater demand for high voltage high power processing techniques with improved efficiency. The essential advantage of multilevel inverters is the improvement in the output voltage signal quality using devices of low voltage rating with lesser switching frequency, thereby increasing the overall efficiency of the system.

The government of India takes a major decision towards renewable energy sources .The Jawaharlal Nehru solar Mission (JNNSM) target to produce 20 gigawatts upto 2022.

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