Energy Management System based on Landsman Converter for Micro Grid using Hybrid Energy Sources

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ABSTRACT: This project offers a manage of micro-grid at an remoted vicinity fed from Wind and Solar photo voltaic primarily based hybrid strength sources. The computing devices used for wind power conversion is Doubly fed Induction Generator (DFIG) and a battery bank is connected to a common DC bus. A solar photo voltaic(PV) array is used to convert solar power and it is evacuated at the common DC bus of DFIG using a Modified Landsman converter in a fee positive way. The frequency and voltage are maintained through an oblique vector manage of the line aspect controller, which is integrated with hunch characteristics. It alters the frequency set points primarily based on the energy level of the battery, so it protect the battery from over charging and deep discharging of the battery. The device is also capable to work when wind power is unavailable. Both wind and solar photo voltaic have most strength factor monitoring(MPPT) algorithm. The system is designed for entire computerized operation taking consideration of all the realistic conditions. The device is additionally furnished with a provision of exterior energy assist for the battery charging except any extra requirement. Neuro Fuzzy Logic algorithm is used to tune the strength of PV systems. A simulation mannequin of the system is designed using MATLAB SIMULINK and the simulation is made for different conditions e.g. unavailability of wind or solar energies, unbalanced and nonlinear loads, low state of charge of the battery.

KEYWORDS: maximum power point tracking, landsman converter, Neuro Fuzzy logic algorithm.

I.INTRODUCTION

The electrical energy delivery requirements will be varied based on the next century power distribution technology processing steps. Several technologies must be accommodated based on the integration of power supply from distribution generation system. The efficiency is the key factor where several modifications is to be made from both thepower supply side and load requirements.

Due to the deregulation of power supply, there may be subsequent changes in the operation of power system and their requirements. These factors are mainly affected the power system standards due the development of Distributed Energy Systems (DES) and its integration. Wind, solar and micro-Hybrid energy systems are some of the important category of DES that allows power generation in micro levels. These sources have some major advantages, it has almost no fuel cost for power generation and available throughout the year. One more advantage is that the line losses will be minimum due to the installations of DES's can be installed nearby to the load demand area in order to avoid network congestion. The DES's have furthermore advantages i.e. in case of any failure in the distribution side of low voltage power supply grid (in USA 110 V and in Europe 230 V) there may be a possibility of island operationof near by DE systems. Theloads can be easily controlled in case of any failure in the nearby micro grids.

The maximum capacity of a micro-grid will be of around1 MVA with a low voltage distribution feeder having an average distance of 1km. The underground system will be well suited for domestic low voltage customers and an overhead system will be provided for the remaining customers in the power system network. There will be a possibility of providing both heat and electricity by means of micro-grid and with combined heat and power (CHP) generating systems. The generated energy can also be stored in storage batteries as well as in flywheels.

One of the major advantages of the development of micro- grid having the ability to control the emission of gases which intern mitigates the climatic conditions. Generally renewable energy sources have very minimum emission of polluted things. Apart from these things, there are plenty of merits in DES such as reliability, improved service quality, cost effective infra structures, high energy efficiency and easy replacement of installations.

There are plenty of challenges in the operation of micro- grids. The technology of operation and the control of micro grids require sophisticated control strategies in order to meet the quality of standards of the power system. The micro-grid inverters could provide normalized frequency and a stable operating voltage for continuously varying loads. These technologies are much attracted in the developing nations like Europe, Japan and USA. Plenty of technical issues are present in the operation of micro-grids and its integration with the power system network.

The micro-grid has to be protected from two major issues. First one related with the maximum number of units connected and the second one related with the short circuit with standing capacity in island operating modes. The short circuit Current can affect the system and may drop down the system stability. In this work a short circuit is made artificially in order to calculate the maximum value of the DES connected with the radial feeders. Based on the value of short circuit currents, the over current protection schemes and relay systems are employed in the micro-grid power system networks.

The operation of micro-grid depends on the operating conditions,loadvariationsaswellasthetypesofmicrosources installed. The short circuit current will vary based on the direction and distance from installed micro sourcesSub sequent changes are made in order to achieve the target of minimizing the losses and economic operations. Due to the faults in the main grid, the content of the micro grid can be modified based on controllable islands of different sizes.There may a possibility of loss of relay coordination system and the over current protection schemes may be in sufficient. Thismay lead to provide dissatisfied operations during faultconditions.

II.RELATED WORKS

Micro-grids were centralized with the electricity system of small-scaleversionsalong withmodernization.Themajorgoals of these systems will be cost reduction, reliability of supply, lowpollutionemissionanddiversificationofenergysources.A stand-alone hybrid system has been developed by Whei-Min Lin et al. The developed system includes solar PV systems, windenergysystemsanddieselengineplantwithanintelligent power controller. A MATLAB/SIMULINK model has been createdinordertosimulatethesystem.Thetrackingandpower control could be achieved through an improved Elman neural network (ENN) algorithm to achieve power point tracking (MPPT) for a radial basis function network(RBFN).

Development of a management and operation of hybrid solar-wind stand alone system has been initiated by Wei Qi et al. The cost function and the power references were computed by the wind-solar systems through a predictive control by analyzing the sampling time. There were two local controllers that can drive two sub systems for the specified power references.

A model established by ChunhuaLiu et al. with the fluctuations of voltages in the system can be described by the unpredictable system changes of the voltage envelop due tothe realandreactivepowerchangesoccuratloadside.Theamount of voltage fluctuations completely depends upon the size ofthe load, capacity of the power system and types ofloads.

III.PROPOSED SYSTEM

Micro-grid is a combination of micro sources and the interconnection of loads with a single controllable system that have the capacity to produce both power and heat energy sources to the nearby areas. The key idea behind a micro-grid will be a distribution generation system formation with a new paradigm.

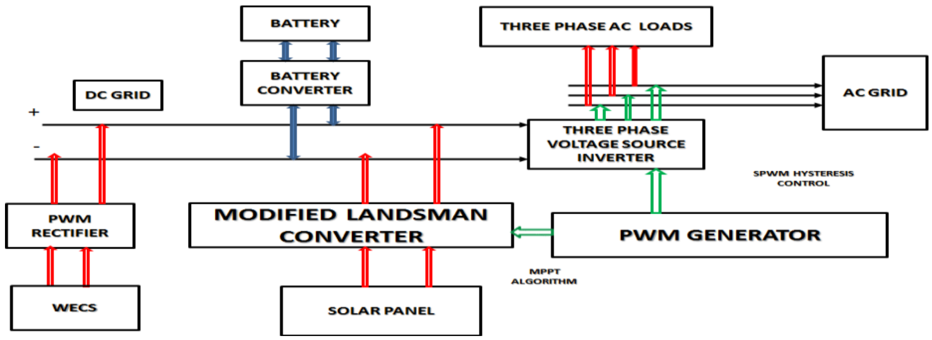

Figure 1: A hybrid AC/DC microgrid system

Figure 1 illustrates a typical hybrid AC-DC micro grid system. Micro-grid has the utility with a controlled cell in a power system. The controlling action of the grid can be measured by a dispatch able load to meet the transmission systemrequirements.Also,thespecialrequirementofthemicro grid customers is line loss reduction, reliability enhancement and the voltage levels, voltage sag and increased efficiency by reducing the usage of heat. The fundamental concept behind the system will be able to minimize the wastage of supply heat during the need. When compared to conventional micro power generation systems, the micro grid has an advantage of a lossless system establishment with the generation power and heat as well as the usage of power by theloads.

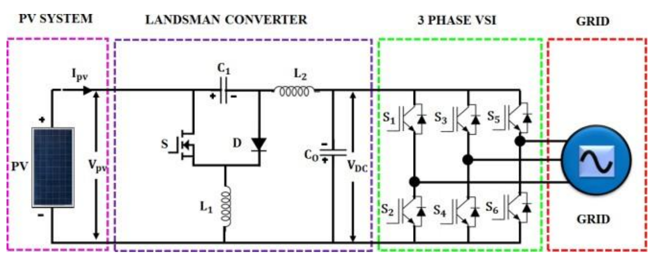

Figure 2: A hybrid AC/DC microgrid system Circuit diagram

A typical configuration of the hybrid system is shown in Figure 2. In this system both the AC and DC links are linked with AC and DC loads. The AC and DC links arelinked together through two transformers and two four quadrants operating three phase converters. AC buses have been connected through a transformer and a circuit breaker and the DC systems are connected through a DC bus having solar PV systems with boost converters. The AC bus is connected witha Wind Energy Conversion System (WECS) model in order to simulate the AC bus. Battery units are connected with the DC bustostoretheenergyduringthesolarPVgeneration.Boththe DC and AC loads connected to their respective DC and Ac grids. The solar PV models either connected in series or parallel. The solar radiation is the key factor for the generation of solar energy.

The voltage output from the PV system is controlled by adding a capacitor in the PV terminal in order to suppress the high frequency voltage ripples. The operation of the DC /DC Converter in a bidirectional mode can adjusted to maintain the DC bus voltages as well as the charging and discharging of storage batteries. There are three converters are incorporatedin this system, they are boost converter, bidirectional and a main converter. All the three converters are integrated to share a common DC bus. WECS system consists of a doubly fed induction generator (DFIG) with back to back AC/DC/AC PWM converter connected between the rotor through sliprings and AC bus. Both the AC and DC buses are connectedthrough a three-phase transformer and the main power converter establishes the exchange of power supply between the DC and AC sides.

Landsman Converter

The Landsman converter is designed to operate in continuous conduction mode (CCM) irrespective of the variation in irradiance level. The circuit operation is divided into two modes

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Mode I – when switch is OFF

When the switch is off, VC1,the voltage across intermediate capacitor C1 reverse biases the diode. The inductor current IL flows through the switch. Since VC1is larger than the output voltage Vout, C1 discharges through the switch, transferring energy to the inductor L2 and the output. Therefore, Vc1 decreases and IL increases. The input feeds energy to the input inductor L2.

Mode II – when switch is ON

When the switch is on, diode is forward biased. The inductor current IL flows through the diode. The inductor L transfers its stored energy to output through the diode. On the other hand, C0 is charged through the diode by energy from both the input and L1.Therefore, vc1increases and IL decreases.

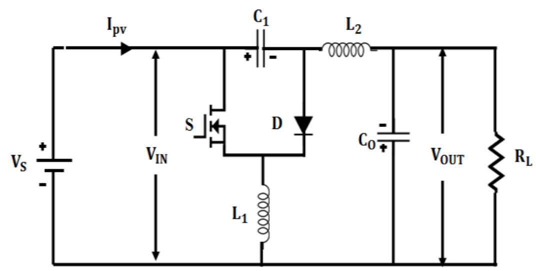

Figure 3: Proposed high gain DC-DC Landsman Converter

This conversion achieves double frequency ripplesuppression in the output voltages. In this project Landsman converter has proposed. This converter increases the performance of the overall system such that with lower duty cycle it supports high outputvoltagegain.In case of any PV modules damages or facing shadow issues this converter helps bypass and generate the constant voltage and current in the PV generation. By using this converter in the solar arrays there are some more advantage like bypassing the shadow issues, Utility of low number of panel to achieve high efficiency of the same. For example, In the normal condition if any shadow occurs in one module of 20 module series connected array it affects the 20 modules performance. But Landsman converter helps to bypass that one particular shaded modules to gain the balance 19 module maximum efficiency.

A. Wind Energy ConversionSystems

Wind energy conversion systems (WECS) convert the kinetic energy of the wind into electricity or other forms of energy. The availability of renewableenergy sources has strong daily and seasonal patterns and the power demand by the consumers could have a very different characteristic Modern wind turbines have lot of commercially available topologies, among thatthevariablespeedwindturbinesaremoreattractive,asthey can extract maximum power at different wind velocities, and thus, reduce the mechanical stress on WECS by absorbing the wind power fluctuations. For a variable-speed wind turbine the generator is controlled by power electronicequipment.

The advantages of Wind Energy over other Non-Conventional Sources are:

- The availability of wind is almost throughout a day and year compare to solarenergy.
- The wind energy is the second largest energy after solar energy for the non-conventional sources of power generation.
- The WECS system provides AC outputs that can be stepped up and integrated directly to the grid unlikely as solar PV systems need a converter and controller to produceACsupplyfromthegeneratedDCenergyfromthe PVarrays.
- The installation and production cost of a WECS system willbeverysmallincostalareaswhencomparedtoadiesel electric power plant
- The power developed in from the WECs system is almost 27% higher at an annual wind speed higher than 18.36kmph at 10m above the surface.

B. Operation ofGrid

In this mode the main converter is to provide stable DC bus voltage, and required reactive power to exchange power between AC and DC buses. Maximum power can be obtained by controlling the boost converter and wind turbinegenerators. When output power of DC sources is greater than DC loads the converteractsasinverterandinthissituationpowerflowsfrom DC to AC side. During this conversion inverter output power requires to synchronous with gird power. So inverter always use grid power as reference power and convert the DC power into AC power. When the grid feeder are down the inverter stop its operation. Therefore inverter perform when the availability of grid supply. Power consumes on inverter from the grid also very minor. The role of battery converter is not important in system operation as power is balanced by utility grid.

C. AutonomousMode

The battery banks are used for backup source. In case of power plant face any technical issues or maintenance shutdown during the interruption period battery act as power sources. By using the lithium ion battery technology, battery performance will act much better. And that can able make it as fast charging to energies the battery. The main converter is controlled to provide stable and high-quality AC busvoltage.

D. Maximum Power PointTracking

MPPT are used to track the maximum power occur in the various power generation system. Recent times this algorithm followed in solar inverter which capable to track the maximum power of no. of panels and set as the ref volt and current to get maximum of its output. The following algorithm would read for every fraction of second to gain max output power.

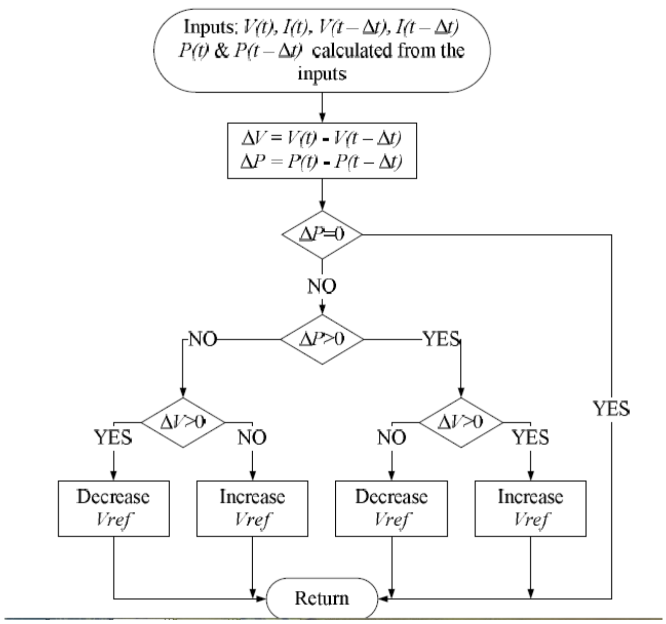

Figure 4: Neuro Fuzzy Logic Controller

Maximum Power Point Techniques are used to extract the maximum power from a PV module and the fuzzy based MPPT technique has been found to provide better results for randomly varying atmospheric conditions as compared to other methods

Neuro fuzzy logic expressed operational laws in linguistics terms instead of mathematical equations.

Fuzzy logic or artificial neural network with nonlinear and adaptive may be used to extract MPP using knowledge based fuzzy rules. This Fuzzy control, the ability of artificial neural networks (ANN) to construct complex nonlinear mapping through a training process helps in finding the maximum power. Neuro fuzzy logics linguistic terms provide a feasible method for defining the operational characteristics of such system.

Neuro fuzzy logic controller can be considered as a special class of symbolic controller. The configuration of Neuro fuzzy logic controller block diagram has illustrated in Figure 4. The Neuro fuzzy logic controller has three major components. The following functions:

- Fuzzification
- Neuro fuzzyinference
- Defuzzification

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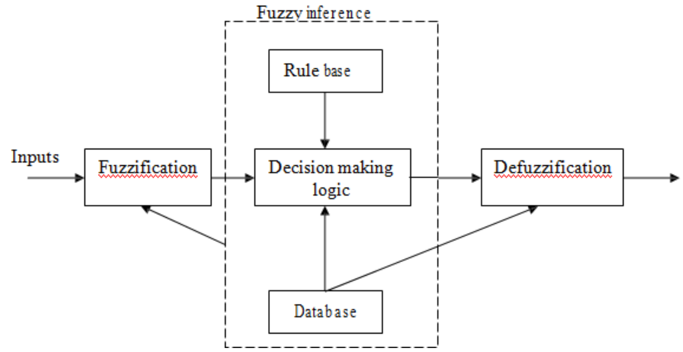

Figure 5. Block Diagram of Neuro fuzzy logic control

Neuro fuzzy system can be viewed as a three layer feed forward neutral network.

- ➢ The first layer represent as **input variables**. MultiplelayerCrip input must be mapped into the neuro fuzzy membership function is known as fuzzification.
- ➢ The middle layer representsas **fuzzy rules** as shown in fig 4.A fuzzy interference method is an adaptive neuro fuzzy methods or an adaptive network network based fuzzy interference system ANFIS.
- ➢ The third layer represent as **output variables**. The neuro fuzzy logic controller must convert its internal neuro fuzzy output variables into Crip values so that the actual system can use these variables. This conversion is called defuzzification.

IV.RESULTS AND DISCUSSION

The developed hybrid micro-grid model is illustrated in Figure5 and is simulated in MATLAB/SIMULINK software environment. The operation is carried out in grid connected mode.Alongwiththehybridmicro-grid,theperformanceofthe DFIGgenerator,PVsystemhasbeenanalyzedthoroughly.The solarirradiation,celltemperatureandwindspeedarealsotaken into consideration for the study of hybrid micro-grid. The performance analysis has been done using the simulated results which are found from MATLAB simulation outputs.

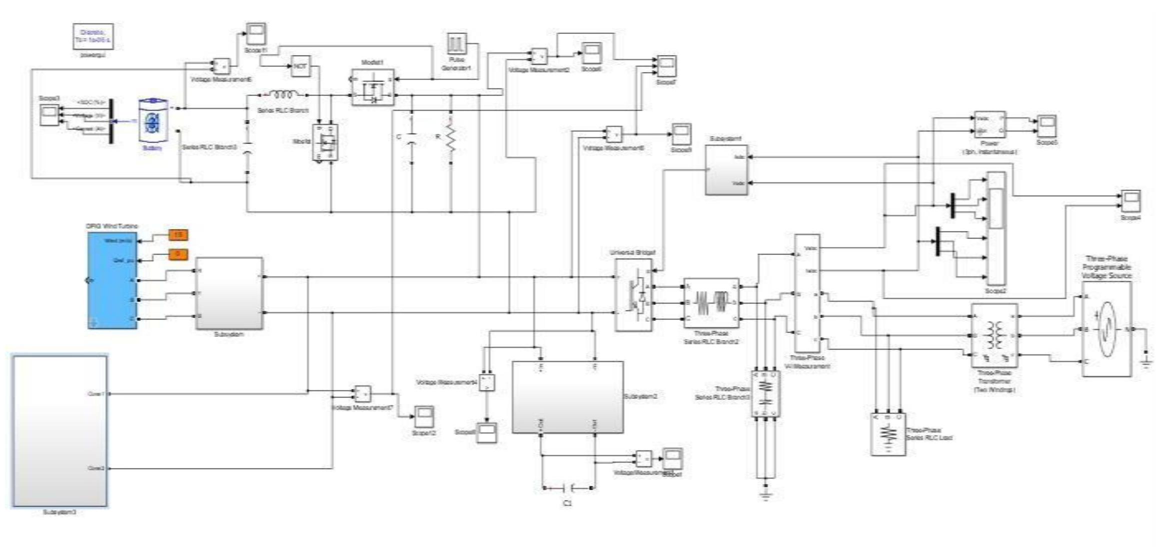

Figure 5: Proposed system simulation diagram

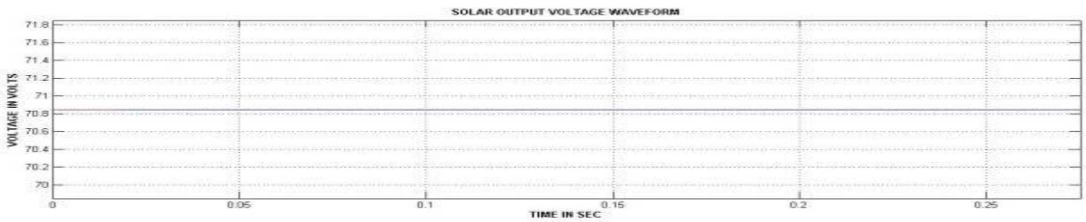

Figure 6: Solar panel output voltage waveform

Figure 6 shows the solar panel output voltage waveform,the temperature and intensity variations affects the panel output voltage waveform, these drawbacks are overcomes by Landsman converter.

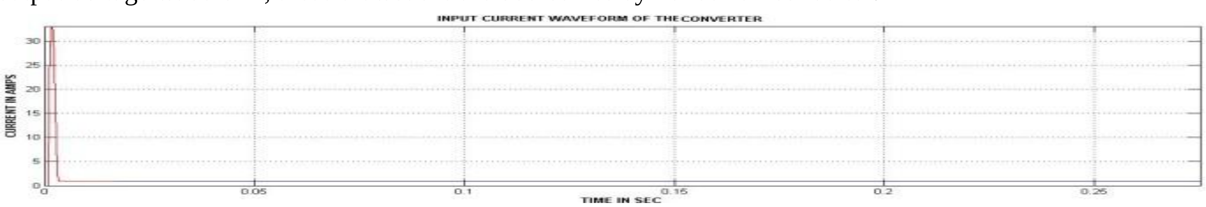

Figure 7 Landsman converter input current waveform

Figure 8 Landsman converter output voltagewaveform

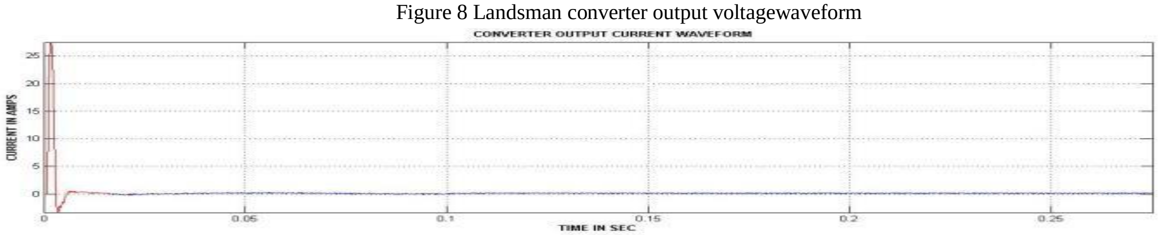

Figure 9 Landsman converter output currentwaveform

Figure 7 and Figure 8 shows the Landsman converter input current and output voltage waveform respectively. This converter reduces the ripple contents as well as to increase the output voltage gain. In Landsman converter, the input and output currents are continuous, and this current further increases the voltage stability.

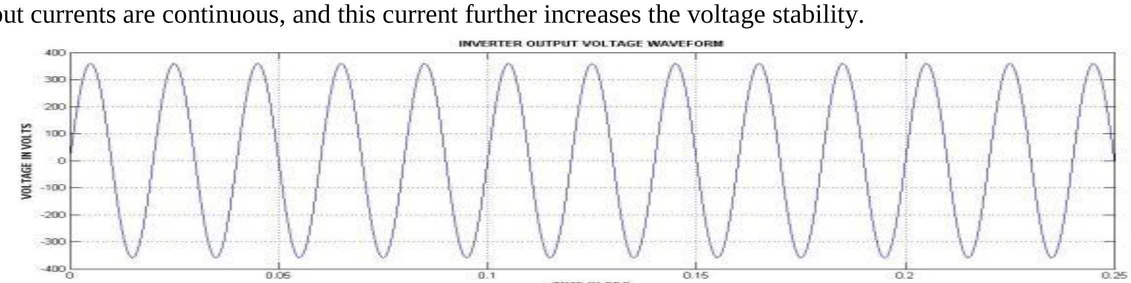

Figure 10 Inverter section waveforms

Figure10 shows the inverter output voltage. D-Q theory isused to compensate there active power as well as to maintain the power factor close to unity. The grid synchronization techniques achieve efficient voltage stability.

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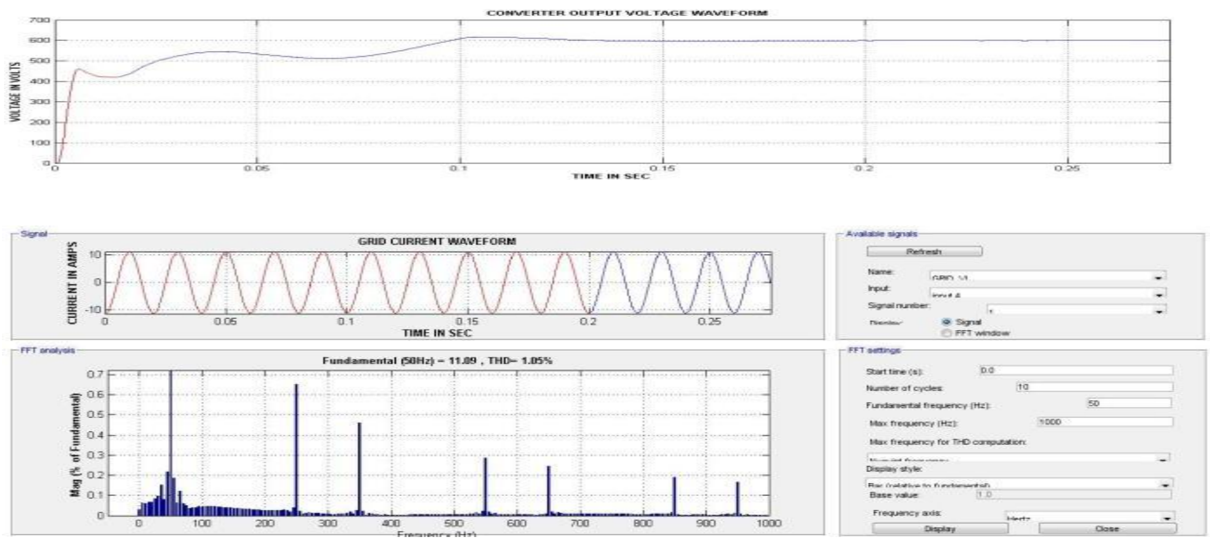

Figure 11 THD results using Fuzzy logic algorithm

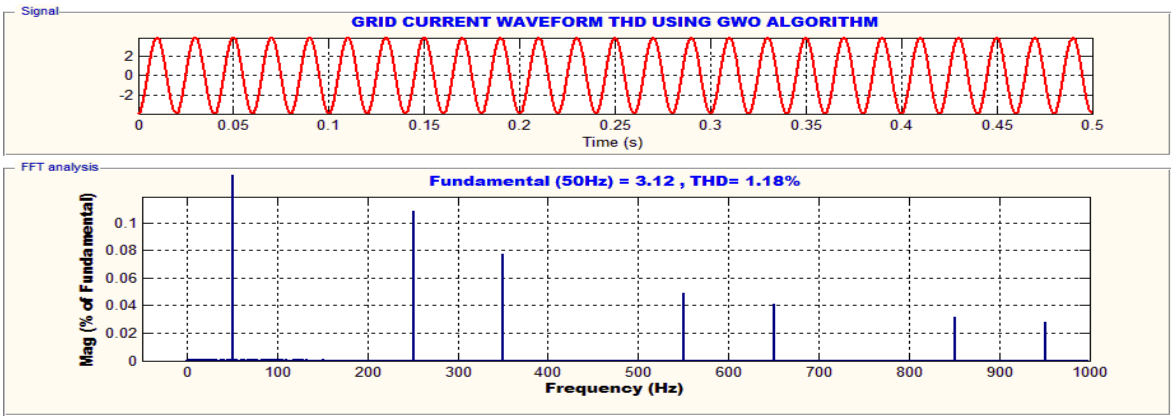

Figure 12 THD results using Neuro Fuzzy logic algorithm

Figure 11 and Figure 12 shows the THD analysis with the implementation of the DC converter with fuzzy logic and neuro-fuzzy logic control algorithms.

Table 1 illustrate the comparison of efficiency of the proposed Landsmanconverterwithexistingconverter.BoththeTHDvaluesand converter efficiency has been improved from the existing converters given in theliterature.

Table 1 Comparison between existing and proposed work

S.No	Parameters	Existing Landsman converter	Modified Landsman Converter
1	THD	1.98	1.18
2	MPPT Efficiency	92%	96%

V.CONCLUSION

In this paper a MATLAB/SIMULINK model has been developed for the modeling and analysis of a hybrid micro-grid for typical non-conventional power generation system. The proposed model of the system has been integrated with power system grid which may lead the system with a hybrid operation. Various design parameters and the system stability parameters being considered for the design of distribution generation systems and their control equipment. A new maximum power pointtracking(MPPT)algorithmwasimplementedinthiswork and the power output can be optimized through this operation. Dc sources have been stabilized by the PV systems and an efficientpowertransfercapabilityhasbeenestablishedbytheexchange of DC and AC grids. The hybrid grid model also eliminates the conventional AC/DC conversion as well as individual AC and DC voltage adjustments as per the load requirements. The proposed hybrid model established a dominated infrastructure that can minimize the conversion losses as well as the reduction of additional DC link requirements. This infrastructure model has the capacity to deliver a reliable power system network with a satisfactory power levels to the consumers. The proposed micro-grid willbe well suited for the industries having small isolated power plants integrated with solar PV system and WECS system as a major source of power supplyunit.

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