Implementation of Hybrid wind solar power system using Artificial Intelligence

Imran Khan
Electronics & Communication Engineering,
Integral University, Lucknow, India
imran005151@gmail.com

Nupur Mittal
Electronics & Communication Engineering,
Integral University, Lucknow, India

Imran Ullah Khan
Electronics & Communication Engineering,
Integral University, Lucknow, India
iukhan@iul.ac.in

Abstract: In this paper, a number of small renewable electricity gadgets unfold over a extensive geographical vicinity are coordinated to supply strength to a given demand region. In this device, some of small synchronized photovoltaic and wind structures deliver electricity in preference to large energy plants transmitting power to faraway areas, therefore, saving energy transmission expenses and stopping energy losses. In disbursed generation, the small renewable turbines are placed on the distribution degree close to load facilities, i.e., consumer facet of the network. There are diverse demanding situations for effective usage of dispensed era like intermittency of renewable sources, power control difficulties, call for uncertainty, and so forth., that should be addressed for reaching the ability benefits of DG systems. This thesis discusses the distinct technologies of DG and occasional voltage networks. The fundamental awareness of this thesis is on hybrid power systems which incorporate of multiple form of electricity resources specifically renewable resources.

Keywords: ANFIS, DG, PV Panel, Solar Power

1. Introduction:

The importance of power in present day international is properly recognised and it is now not feasible to create a evolved society without dependable and sustainable strength structures. The principal recognition of electricity engineers is the continued improvement of structures that are dependable, green and sustainable. The challenges related with big-scale energy generation and transmission structures are the principal driving elements behind exploration of different power deliver alternatives. Increasing greenhouse emissions coupled with rising power desires have triggered a international situation for environment and climate alternate. To help lessen emissions and enhance the penetration of energy in growing international locations, there has been an boom in the integration of renewable power. Technological improvements in electricity electronic structures and declining electricity garage costs have led to a shift from conventional to renewable power in the electricity region. Typically, power systems include of large centralized energy vegetation at generating websites transmitting bulk electric power over long distances thru

interconnected high voltage transmission strains and distributing at customized voltages. In the regulated market, huge utilities own and hold these technology, transmission and distribution facilities in a monopolized way. Increased environmental difficulty and fossil gas scarcity spurred the electric industries to usher in an generation of dispensed era (DG) wherein more than one small renewable electricity devices unfold over a geographical vicinity are coordinated to serve energy wishes. Instead of a big energy plant transmitting strength over long distances, we now opt for a range of small synchronized photovoltaic and wind structures offering strength at the distribution degree near to load centers, i.e., client aspect of the network. Renewable energy has emerged as a feasible choice for contributing to electric powered energy deliver in growing nations due to persevering with technological advancements, value deductions and boom in electricity demand. Solar and wind energies are the maximum attractive alternatives to fossil fuels due to the fact these are inexhaustible, freely available, fee effective and pollutants unfastened. There are diverse technical challenges like intermittency, electricity management, demand uncertainty, etc., that must be tackled for successfully harnessing the ability benefits of DG gadgets and making sure the reliable operation of the machine. Hybrid power structures which incorporate of extra than one type of strength assets in particular renewable assets are turning into extra possible in comparison to vintage usual strength systems. Consequently, there is an extensive awareness on this area and numerous models have been proposed in latest years for dependable and green assimilation of intermittent renewable resources in the electricity device to reduce burden on the application grid. This thesis offers a simulation of wind/solar/battery hybrid device with application grid appearing as again-up support for presenting a variable load the use of simulink tool.

The technology for DG vary broadly from constructional factor of view. As discussed formerly, DG devices are small scale turbines that input power, usually a few kilowatts to upto 10 MW into the distribution network. There is a trendy perception that DG simplest includes clean renewable electricity. A DG unit can work on renewable strength and even fossil fuels. Depending on the type of era, disbursed generation can be labeled as

both renewable and non-renewable. DG technologies vary substantially with the score. On the basis of rating, the DG can be classified as: Micro (1 Watt to 5 kW), Small (5 kW to 5 MW), Medium (5 MW to 50 MW) and Large (50 MW to 300 MW). The primary unit of a Solar/Photovoltaic machine is a cell that works on the precept of photovoltaic effect. It is usually a p — n junction diode made of doped silicon crystal and can produce only a miniscule quantity of electricity. Hence, to generate huge quantities of energy, a quantity of cells are linked collectively to shape PV modules which in flip are linked to form arrays. The quantity of energy harnessed from a PV machine tiers from a few kilowatts for residential systems to several megawatts for application scale applications. PV mobile technologies have advanced over the years and are categorised into 3 generations: first generation PV structures based totally on unmarried crystalline or multi crystalline silicon wafer technology; second technology PV structures primarily based on skinny movie PV technology; 0.33 generation PV cells based totally on concentrating PV (CPV) and organic PV cells. Thin film technology are appropriate from cost effective point of view.
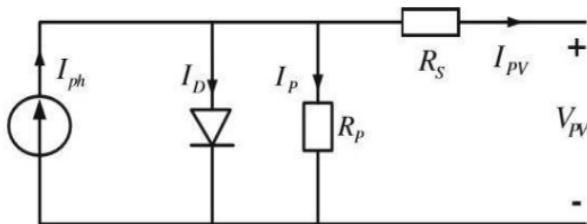

Figure 1. PV panel circuit model

2. Related Work:

Aissa Chouder; Santiago Silvestre; Nawel Sadaoui & Lazhar Rahmani present a paper titled "Modelling and Simulation of a Grid Connected PV System Based on the Evaluation of Main PV Module Parameters (2012)" [1]. In this paper a new approach for modeling and simulation of a grid linked photovoltaic device has been presented and established. The device involves a 3.2 KWp rated PV machine which includes a PV generator and a single segment grid linked inverter. The provided version of PV gadget based totally on unmarried diode lumped circuit fits the IV traits pretty accurately.

Xiandong Ma; Yifei wang & Jianrong Qin present a paper on "Generic Model of a Community Based Microgrid Integrating Wind Turbines, Photovoltaics and CHP generations (2013)" [2]. This paper offers modeling, manipulate and integration of hybrid era based microgrids and clever tracking techniques. The system has been simulated below specific operating eventualities taking into account the effect of climate conditions and energy electronics on the operation of wind and solar devices and interaction between unique generation devices. The gadget has additionally been examined below symmetrical

and asymmetrical faults to observe the technique of isolation and reconnection of a particular allotted era unit and its impact on the device.

A. Jenifer; R. Newlin Nishia; G. Rohini & V. Jamuna present a paper titled "Development of MATLAB Simulink Model for Photovoltaic Arrays (2012)" [3]. This paper gives the mathematical version for a photovoltaic array advanced the use of MATLAB. Taking into account the non-linear characteristics of PV module, the version has been designed with most power point tracking (MPPT) for PV machine. The dynamic analysis of converters has been studied.

Yu Ru; Jan Kleissl & Sonia Martinez gift a paper titled "Storage Size Determination for Grid-Connected Photovoltaic Systems (2013)" [4]. —In this paper, the hassle of determining the best length of battery storage used in photovoltaic systems with grid guide has been studied. In the model described in paper, strength is generated from PV gadget and is used to deliver the masses. Excess power generated is both transferred to the grid or stored in a battery, and power is taken from the software grid if the PV technology and battery garage can't meet the demand. Electricity can be purchased from the grid throughout low fee, and be bought returned when the price is high. The objective of the have a look at is to decrease the price of strength buy from the software grid and the battery discharge price whilst at the same time enjoyable the demand and decreasing strength buy from the grid.

Derso Sera; Laszlo Mathe; Tamas Kerekes; Sergiu Viorel Spataru & Remus Teodorescu gift a paper titled "On the Perturb-and-Observe and Incremental Conductance MPPT Methods for PV Systems (2013)" [5]. This paper affords an evaluation of perturb-and-observe (P&O) and incremental conductance (INC) MPPT techniques. This foremost intention of this paper is to assist in the selection method for right MPPT method appropriate for any specific PV gadget. The two techniques are analyzed both mathematically and almost. On the foundation of mathematical analysis, it is revealed that there is no actual difference among the two techniques. Experimental results display that the P&O and INC methods are basically equal.

Pablo Garcia; Carlos Andres Garcia; Luis M. Fernandez; Francisco Llorens & Francisco Jurado gift a paper on "ANFIS-Based Control of a Grid-Connected Hybrid System Integrating Renewable Energies, Hydrogen and Batteries (2014)" [6]. This paper presents an adaptive neuro-fuzzy inference system (ANFIS) primarily based electricity control machine of a grid linked wind/PV/battery/gas mobile hybrid system. A wind turbine and photovoltaic solar panels are used as number one electricity assets and hydrogen based power garage gadget based totally and batteries are used for power garage. The strength that need to be generated or stored taking into account the electricity requirement of the grid, to be had

strength, the nation-of-price (SO C) of the battery; is decided with the aid of the ANFIS based totally supervisory manage device. Also, an ANFIS based totally controller is used in the three-section inverter, which connects the hybrid machine to grid.

A.D. Jones & C.P. Underwood present a paper titled "A Modelling Method for Building-Integrated Photovoltaic Power Supply (2015)" [7]. In this paper, PV fill issue technique is used to broaden an performance version of power output in which the fill factor version predicts power output values that observe or do not comply with the fashion of measured values. The model is examined the use of experimental data accomplished from a 39.5 kW building included PV array.

3. Methodology:

The value of renewable power generated via wind turbine and PV panels depends on the weather sample of the unique site because of the intermittent nature of solar radiation and wind speed. Solar irradiance and wind velocity statistics is required to check the feasibility of the hybrid gadget at a site. For economic operation of the gadget, top-quality sizes of PV arrays and batteries are calculated for a given load on the foundation of climate statistics [8]. The hybrid gadget beneath consideration is shown in figure under and consists of PV panels, wind turbine and battery. Wind turbine and PV panels act as primary sources of power running maximum of the time. The gadget is connected to the software grid and a variable load. The purpose of battery is to save greater energy when demand is less than era and deliver saved energy when renewable technology isn't sufficient to meet the call for in the course of adverse weather situations. Utility grid comes into play while both on-web page power manufacturing and power stored in battery are now not sufficient to balance the load. To decrease the errors among strength supply and load call for which varies from 20 kW to three hundred kW, switching is done with the assist of ANFIS controller. Thus, the system is intended for minimal usage of utility grid, thereby, reducing power charges.
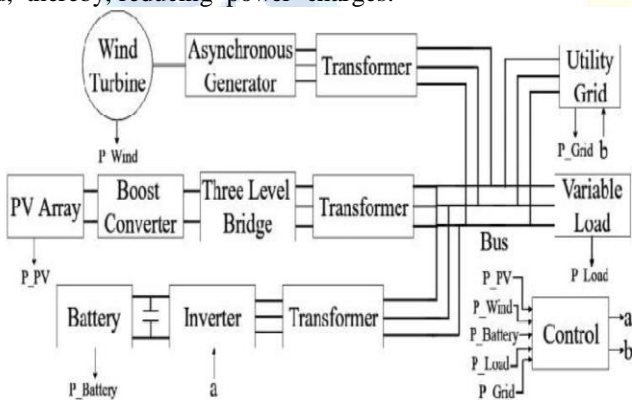

Figure 2: Configuration of grid connected hybrid system

A. Modelling of Wind Energy System

The wind turbine system present in the model has a rated capability of 280 kW and working voltage of 460 V which is stepped down to 250 V using a transformer. Wind output is connected to a not unusual AC bus alongside with the inverter output of PV gadget. The output energy of any wind turbine depends upon its dynamic characteristics and wind speed at the hub peak. The quantity of mechanical strength P extracted with the aid of the WT is given as [10]:

$$P = \frac{1}{2}\rho\pi R^2 C_p(\lambda, \beta)V^3$$

Where p denotes air density, R is the radius of turbine blade, Cp is the power coefficient, A is the Tip Speed Ratio *(TSR), 13* is the blade pitch angle and V is the wind velocity.

B. Modelling of PV System

A PV cell that works on the principle of photovoltaic impact is the simple constructing block of a PV machine. It is a basically a p — n junction diode made of doped silicon crystal and can generate best a small amount of electricity. Hence, a huge variety of cells are joined collectively electrically to shape PV modules which in flip are linked to shape arrays so as to produce usable electricity. The PV gadget used has a rated capability of two hundred kW working at 250 V. The power a PV panel generates depends upon the quantity of sun radiation incident on its floor and mobile temperature. Both solar irradiance and temperature range according to the vicinity of the sun in the sky. Hence, seasonal changes additionally have a great impact on PV electricity manufacturing. Total radiation incident on an inclined PV panel can be given as follows [9]:

$$I_T = I_b R_b + I_d R_d + (I_b + I_d)R_r$$

Where lb stands for direct normal radiation, id is the diffuse radiation, Rd is the tilt factor for diffuse radiation and Rr is the tilt factor for reflected radiation.

C. MPPT Technique (Incremental Conductance)

For efficient utilization of the PV array, incremental conductance technique is used. This method is based totally on the principle that the sum of instantaneous conductance (Ipv/Vpv) and incremental conductance (AI pv AVpv) at most power factor (MPP) is 0 high-quality on the left side of MPP and negative on the right aspect [11]. Using the values, this technique detects the ideal operating point of the PV device

dI/dV=-I/V	*at MPP*
dI/dV>-I/V	*left of MPP*
dI/dV<-I/V	*right of MPP*

D. ANFIS Controller

The switching operation of battery and grid connection is managed via ANFIS software by using evaluating renewable power output, battery discharge level and load. To reduce the error between strength supply and load call for which varies from 20 kW to 300 kW, switching is done with the help of ANFIS controller. Thus, the machine is meant for minimum utilization of software grid, thereby, lowering electricity prices. Conventional mathematical gear are now not appropriate for dealing with non-linear or real world tactics which have the element of uncertainty. Soft computing techniques which consist of fuzzy inference structures and artificial neural networks are more capable of coping with such problems due to their inference and model qualities and have already been effectively applied in numerous areas. They provide an powerful answer to the approximate and vague nature of actual global troubles. To make choices while dealing with imprecision, fuzzy structures use their inference capabilities and appoint approximate reasoning using if — then rules. If A and B are fuzzy units characterized by using suitable membership capabilities, then fuzzy if — then rules are expressions in the form of IF A THEN B [12].

Artificial neural networks are multi-layered feed forward adaptive networks with getting to know capability. These networks which emulate the operating of human brain have computational neurons connected to each different by directional links and weight factors in a layered manner. Hybrid strategies shaped via fusion of unique synthetic intelligence tools have additionally been developing. Neuro-fuzzy techniques have become quite distinguished for addressing complicated programs and can be defined as aggregate of adaptive neural networks and fuzzy inference structures. Adaptive neuro fuzzy inference device or simply ANFIS is one such neuro-fuzzy approach and is derived through embedding the fuzzy inference gadget into the configuration of synthetic neural networks. It is basically a fuzzy machine which applies neural gaining knowledge of regulations to become aware of and track its parameters and shape based on available facts. In the hybrid gadget proven in determine 1, there are two manage alerts a and b which are derived by means of the ANFIS controller the usage of the available facts from wind and sun gadgets. These alerts are used for the switching of battery and grid connection to the not unusual bus relying upon the load conditions.

4. Result and Discussion:

Figure 3. Simulink model representing wind and solar hybrid neuro fuzzy system.

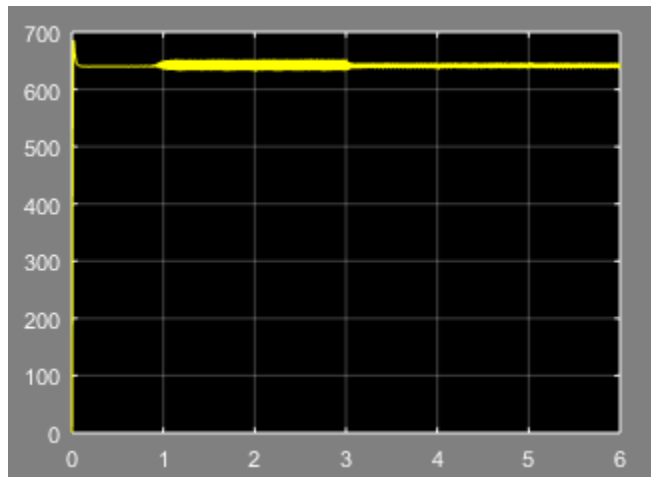**Figure 4(a): Average current output at DC converter.**
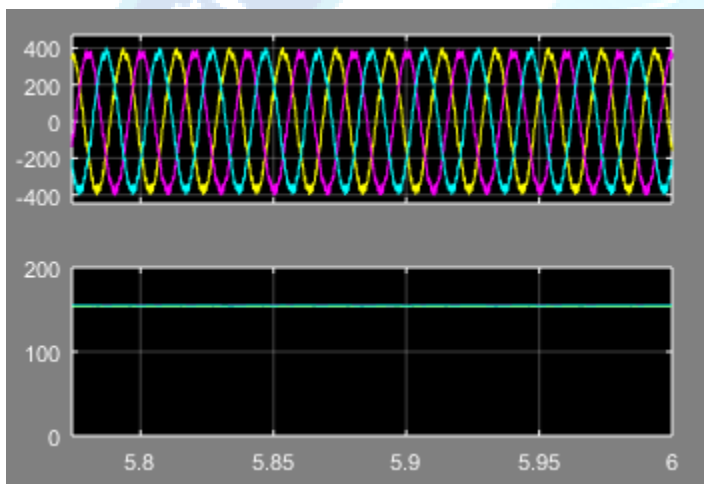
Figure 4(b) DC voltage at inverter input

Figure 4(c): Line to line voltage and rms phase voltage
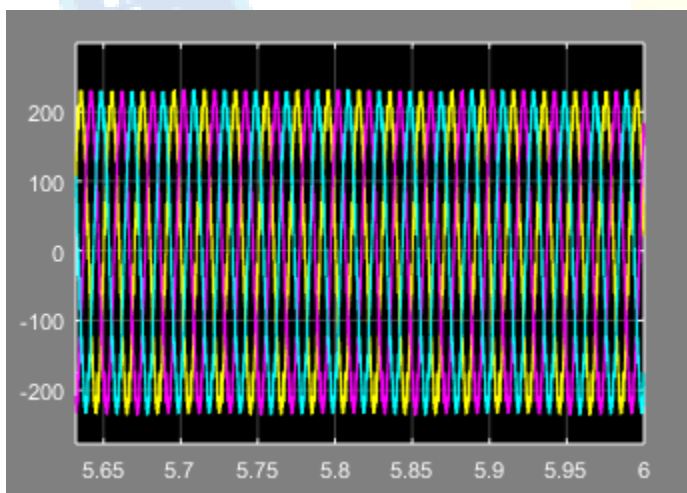

Figure 5: Final voltage at load end

5. Conclusion:

In this paper, we have discussed the modeling and simulation of various DG technologies which include PV, wind and lead-acid battery systems, in brief discussed micro grid framework and boom of renewable strength in strength marketplace and analyzed the PV/wind/grid/battery machine with variable load. Hybrid renewable generation has the ability to fulfill rising energy needs and reduce burden at the software grid and stopping greenhouse emissions and climate change. For dependable utilization of renewable strength assets, technological developments in power electronics and digital control structures are needed. Hybrid era technique has emerged as a ultimate alternative to standard era.

References:

[1] Aissa Chouder; Santiago Silvestre; Nawel Sadaoui & Lazhar Rahmani , "Modelling and Simulation of a Grid Connected PV System Based on the Evaluation of Main PV Module Parameters " Simulation Modelling Practice and Theory 20 (2012) 46–58

[2] Xiandong Ma; Yifei wang & Jianrong Qin present a paper on "Generic Model of a Community Based Microgrid Integrating Wind Turbines, Photovoltaics and CHP generations", Applied Energy, Volume 112, December 2013, Pages 1475-1482

[3] A. Jenifer; R. Newlin Nishia; G. Rohini & V. Jamuna present a paper titled "Development of MATLAB Simulink Model for Photovoltaic Arrays" International Conference on Computing, Electronics and Electrical Technologies (ICCEET) 2012.

[4] Yu Ru; Jan Kleissl & Sonia Martinez gift a paper titled "Storage Size Determination for Grid-Connected Photovoltaic Systems" arXiv:1109.4102v2 [math.OC] 10 Jan 2012.

[5] Derso Sera; Laszlo Mathe; Tamas Kerekes; Sergiu Viorel Spataru & Remus Teodorescu gift a paper titled "On the Perturb-and-Observe and Incremental Conductance MPPT Methods for PV Systems" IEEE Journal of Photovoltaics Volume: 3 , Issue: 3 , July 2013.

[6] Pablo Garcia; Carlos Andres Garcia; Luis M. Fernandez; Francisco Llorens & Francisco Jurado gift a paper on "ANFIS-Based Control of a Grid-Connected Hybrid System Integrating Renewable Energies, Hydrogen and Batteries" IEEE Transactions on Industrial Informatics Volume: 10 , Issue: 2 , May 2014.

[7] A.D. Jones & C.P. Underwood present a paper titled "A Modelling Method for Building-Integrated Photovoltaic Power Supply", BSERT Volume: 23 issue: 3, page(s): 167-177 August 1, 2015

[8] W.D. Kellogg, M.H. Nehrir, G. Venkataramanan, V. Gerez, "Generation Unit Sizing and Cost Analysis for Stand-Alone Wind, Photovoltaic, and Hybrid Wind/PV Systems^(↑1), IEEE Transactions on Energy Conversion, Vol. 13, No. 1, 1998, pp 70-75.

[9]M.K. Deshmukh, S.S. Deshmukh, "Modelling of Hybrid Renewable Energy Systemsl†, Renewable and Sustainable Energy Reviews 12, 2008, pp 235-249.

[10] Pragya Nema, R.K. Nema, Saroj Rangnekar, ↑|A Current and Future State of Art Development of Hybrid Energy

System using Wind and PV-Solar: A Review Renewable and Sustainable Energy Reviews 13, 2009, pp 2096-2103.

[11]Dezso Sera, Laszlo Mathe, Tamas Kerekes, Sergiu Viorel Spataru, Remus Teodorescu, ↑|On the Perturb-and-Observe and Incremental Conductance MPPT Methods for PV Systems IEEE Journal of Photovoltaics, Vol. 3, No. 3, 2013, pp 1070-1078.

[12]Pablo García, Carlos Andrés García, Luis M. Fernández, Francisco Llorens, Francisco Jurado, "ANFIS-Based Control of a Grid-Connected Hybrid System Integrating Renewable Energies, Hydrogen and Batteries^(↑1), IEEE Transactions on Industrial Informatics,Vol.10,No.2, 2014, pp 1107-1117.

[13] Anurag, R. Sharma, " Load Forecasting by using ANFIS", International Journal of Research and Development in Applied Science and Engineering, Volume 20, Issue 1, 2020.

[14] R. Sharma, Anurag, " Load Forecasting using ANFIS A Review", International Journal of Research and Development in Applied Science and Engineering, Volume 20, Issue 1, 2020.

[15] R. Sharma, Anurag, " Detect Skin Defects by Modern Image Segmentation Approach, Volume 20, Issue 1, 2020.

[16] Anurag, R. Sharma, " Modern Trends on Image Segmentation for Data Analysis- A Review", International Journal of Research and Development in Applied Science and Engineering, Volume 20, Issue 1, 2020.

[17] A.D. Jones, C.P. Underwood, ††A Modelling Method for Building-Integrated Photovoltaic Power Supplyl†, Building Services Engineering Research and Technology, Vol. 23, Issue 3, 2002, pp 167-177.