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Simulation of Solar Power Plant using Artificial Intelligence with MATLAB/Simulink

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***Abstract*—This Paper deals with Promoting of energy savings and solar energy development and AI Technics in new research policy are two objectives of the paper. The currently continuing working on part of global development of various tools allowing managing energy demand. Managing energy demand, extending supply and production sources of energy, and also developing research activities on renewable energy resource. The major challenges of the actual complementary objectives are, first, promoting energy savings, especially in sectors of daily use (housing, offices, shops and transport) where Consumption is high and, secondly, promoting renewable energy (biomass, solar Power, geothermal energy and heat pumps) and these are the most promising as a future energy technology. The performance of PV system can be enhanced by power converter with intelligent control techniques using fuzzy logic and develop the simulation model to improve the efficiency of solar power generation. The Maximum Power Point Tracking algorithm is most important suggestion for improve the efficiency of Solar power generation at solar power plant. The application of Maximum Power Point tracking in the PV module was developed to achieve high performance in actual field.**

***Index Terms*— Solar Energy, Artificial Intelligence, Photovoltaic (PV), Modelling, Maximum Power Point Tracking (MPPT).**

I. INTRODUCTION

As energy demands around the world increase the need for a renewable energy source that will not harm the environment is also increased. The research on solar energy that average incident solar energy received in earth's surface is about 600W/m^2.but the actual value varies quite considerably. It has the advantage of being free of cost, non-exhaustable and completely pollution free. The most important being that of collection and concentration of solar energy and its conversion to the electrical from through efficient and comparatively economical means. Some projections indicate that the global energy demand will almost triple in the years of 2050.Total installed capacity of power generation in India as on Aug 2015 is 284,634 MW out of which 199,947MW is being generated by thermal power plants which accounts for 70.25% of total power generation till date [1]. Still 67.2% of the population is not having access to electricity [2].The main source of energy comes from Non Renewable sources (Solar, wind, geothermal energy and heat pumps)

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consisting about 87.70% while the Renewable Power Plants contribute the remaining 12.30% of the total installed capacity as shown as in Fig1 [3]. Now our country has significant Renewable Resource for generation of Electrical power from renewable energy sources like Solar Energy, wind Energy, hydro Energy, biomass. The population of whole world is growing, and some studies predict a world population of 9billion around 2040 in contrast to the 7 billion people living on the planet now. As on 30.9.20 12, total installed capacity of India is 2, 07,876 MW, out of which 20,162 MW is generated from Renewable Energy sources viz., Wind, Biomass, Solar etc. For promoting solar power and also seen increase the load demand day per day, the Government of India has started the Jawaharlal Nehru National Solar Mission (JNNSM) to increase scale and drive down costs to grid parity. It is targeted to generate 22,000 MW by 2022.
Today in the same field we are discuss many researches are going on to increase the efficiency of solar power production and reduce it cost The performance of photovoltaic system can be improved by using power converter with AI control techniques to develop the circuit model to improve the generation efficiency of solar power. MPPT algorithm is one powerful suggestion for Solar systems to improve the efficiency. In controller scheme of the system or process being controlled is modelled. But in a fuzzy controller and AI Controller the focus is on the human operator's judgment. Whereas fuzzy logic gives a good results and powerful representation for measurements of uncertainties present in that problem [5].

II. Artificial Intelligence

AI is a combination of physiology, philosophy and also computer science. The artificial intelligence exhibited by machines or software with interfacing. It is also the name of the study of academic field which studies how to create computers and computer software that are capable of artificial intelligent behaviour of machine. The goals of artificial intelligence development, research include learning, natural language processing, perception reasoning, knowledge, planning, and the ability to move and also manipulate the sets objects. Artificial intelligence is still among the field's long-term goals.[10] Today popular approaches include traditional symbolic AI, computational intelligence and statistical methods.

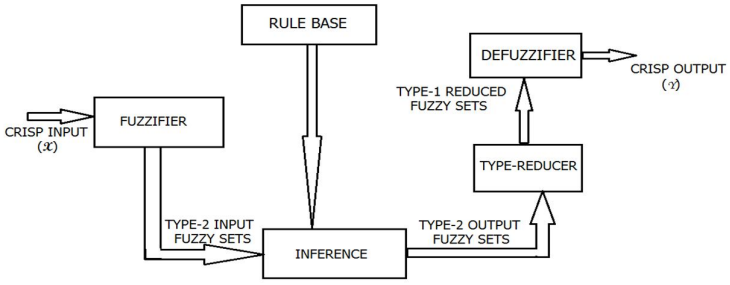

Fig: 1- Artificial Intelligence System

In the AI a large number of tools and options are to be implemented by using artificial intelligence, including versions of mathematical optimization, logic, search, economics, and methods based on probability and many others tools are developed. The artificial intelligence field is most interdisciplinary, in which large number of sciences and linguistics, philosophy with professions converge, including computer science and neuroscience, mathematics, psychology as well as other specialized fields such as artificial psychology.[6] The field was founded on the claim that a central property of human intelligence[7]. Fuzzy logic is one of the methods of artificial intelligence. The input quantities are X1, X2 and X3[8]. These inputs are converted to their corresponding fuzzy variables by a technique known as fuzzification before application to the Fuzzy Inference Engine. After fuzzification, the fuzzified inputs are given to the fuzzy inference engine, which, following the given fuzzy rules, gives the output as shown in the Fig. 2.

II. Block Diagram of Solar Power Plant

The block diagram of PV solar power plant modules or arrays, which convert solar energy in the form of solar irradiation into electric energy in the figure 3. The changes the level of the voltage to match it with the electrical appliances that are supplied by this system by using DC-DC converter. This DC-DC converter may be either buck or boost or buck-boost converter contingent on the required and available voltage levels. The

maximum power point tracing system coerces the maximum power from the PV modules. [9]A bi-directional converter issued to supply the current in the both directions is used to charging of the battery that maximum power is transferred to load. Due to the complexity of the non-linear nature and tracker mechanism of PV system, the artificial intelligence based technique in order to observe the maximum available power of PV module with maximum efficiency, which electrical energy is stored. When there is a power surplus and the energy stored by the battery is discharged into the load [10].

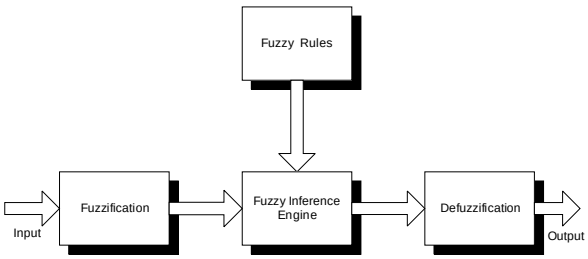

Fig: 2- Fuzzy Logic System for PV system

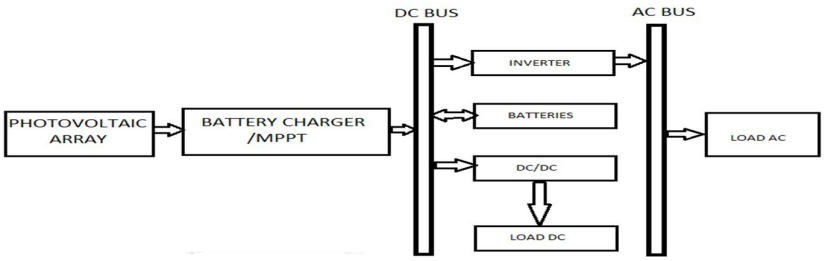

Fig: 3- Block Diagram of Solar Power Plant

The primary component of Photo voltaic systems is power conditioning unit (PCU). The PCU converts the DC power from Photo voltaic array into Alternating supply depends upon the voltage and quality requirements power of the utility load. A bi-directional interfacing is made between the Photo voltaic system alternating output supply and the electric utility load and network circuit, typically on-site distribution panel or service connection at entrance. This allows the alternating power generated by the Photo voltaic system to either supply on-site electrical loads or networks to back-feed the connected load when the Photo voltaic system output is more than the on-site load demand. This feature is used safety feature and required in all load-connections. [11]These are determined by the total required area to be needed and install the system. Some Photo voltaic arrays will also require regular cleaning and maintenances of system. This could represent the additional costs especially for the large scale systems energy use and cost system size depends mostly on energy use, solar resource and component efficiency Reducing energy consumption greatly reduces the initial capital cost investment necessary PV systems can be cost competitive in locations with high energy prices and Net metering programs. The assumption of that Photo voltaic system is expensive is therefore relative to the solar resource and utility energy prices in location indirect benefits to the Emissions reductions provide by a wide range of economic, health benefits and environmental. [12]A solar cell, or photovoltaic cell, is an electrical device that converts the energy of light directly into electricity by the photovoltaic effect, which is a physical and chemical phenomenon. It is a form of photoelectric cell, defined as a 10 device whose electrical characteristics, such as voltage and current, or resistance, vary when exposed to light. Solar cells are the building blocks of photovoltaic modules, otherwise known as solar panels. [13]The P-V and I-V characteristics of Solar cell if no load is connected with solar panel which is sitting in the sun, an open circuit voltage V_{oc}will be produced but there are no current follows in the circuit or load. If the both terminals shorted of the solar panel, a short- circuit current ISC will flow but the output voltage across the load or circuit will be zero. In the both cases, zero power is delivered from the solar panel. When a load is connected, we need to consider the I-V curve of the panel and the I-V-curve of the load to figure out how much power can be delivered to the load.

The characteristics equation for a photovoltaic cell is given by

$$I_o = (N_p \times I_{ph}) - (N_p \times I_{rs})\left(\exp\left[\left(\frac{q}{kTA}\right)\right] \times \left(\frac{V_o}{N_s}\right)\right) - 1 \quad (1)$$

Where

$$I_{ph} = (I_{scr} + k_i) \times (T - T_r) \times \frac{S}{100} \quad (2)$$

$$I_{rs} = I_{rr} \times \left(\left(\frac{T}{T_r}\right)^3 \times \exp\left(q\frac{E_g}{kA}\right) \times \left(\frac{1}{T_r}\right) - \left(\frac{1}{T}\right)\right. \quad (3)$$

$$T_r = (T_{r1} - 32) + 273 \quad (4)$$

I_o &V_o = Cell output current and voltage I_{rs} = Cell Reverse saturation current

T = Cell Temperature in Celsius k =Boltzmann's constant: 1.38 * 10-23 J/K

q = Electron charge: 1.6*l0-l9 C K_i = Short circuit current temperature coefficient at I_{scr}

S = Solar radiation I_{scr} = Short circuit current at 25 degree Celsius

I_{ph} = Light generated current

IV. Modelling and Simulation

In present research MPPT and Fuzzy Logic are used because of its ability on the complex geometry and nonlinearities of biologically realistic models, with and without interfering to handle more specific details that include biophysical properties, specific anatomical and also high degree of abstraction Developing alternative energy resources with high efficiency and low emission has become of great importance with increasing concerns of global warming, damage to environment and ecosystem fossil fuel deficit, high oil prices. The concern PV solar energy is free from pollution clean, renewable energy with a long service life and high reliability [14]. A photovoltaic system converts energy from direct sunlight into electric energy on the basic of principle of a photovoltaic system which is photovoltaic effects. Photovoltaic Cells may be grouped form panels or modules. The simulation and modelling of PV system have been making a great transition from a part of power generation in this percentage. Study of photovoltaic systems, in efficient manner requires knowledge of the (I-V) and (P-V) characteristic curves of photovoltaic modules. Research and development is going on to improve the efficiency of PV panel and also to maximize the power output from the panel of solar cell. The maximized output power achieved by using the maximum power point tracing system minimizes the losses in the DC to DC converter. In this paper, a DC-DC buck boost converter is used with minimum number of switches which can work in maximum power point tracing system mode to produce maximum output at all insolation levels of solar plant. [15] .A photovoltaic array is simplest interconnection of number PV modules in serial or parallel. The electrical power generated by individual modules is not be sufficient to meet the requirement of electrical applications, so the modules are secured in a connected grid form or as an array to gratify the load demand [16]. In an array, the modules are connected like as that of cells connected in a module. Generally the making of photovoltaic array and the modules are initially connected in serial manner to obtain the desired output voltage, and then strings so obtained are connected in parallel in order to produce more current based on the requirement [17].

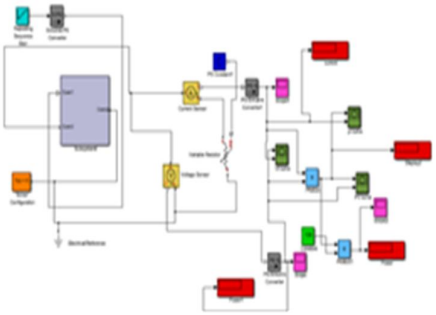

Fig: 4- Simulation of Solar Panel

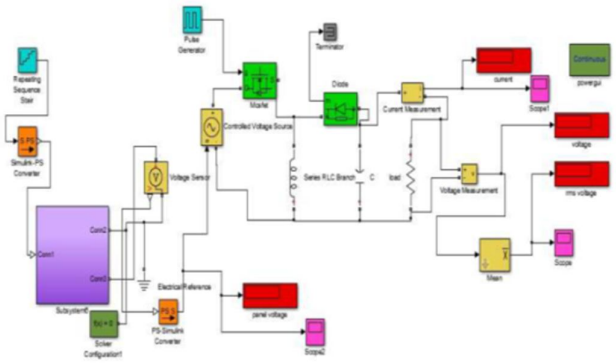

Fig: 5- Simulation of Interconnection of Solar Panel with Buck Boost Converter

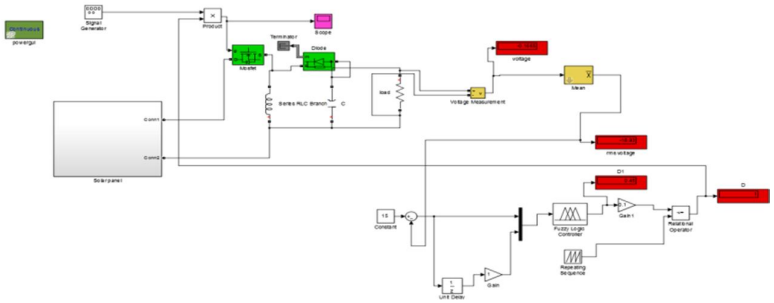

Fig: 6- Solar Power Plant with Fuzzy Logic Based Buck Boost Converter

V. SIMULATION RESULT

To illustrate the effectiveness of the proposed method, simulation studies have been carried out by simulation with MATLAB/Simulink MPPT of a photovoltaic panel of 36 cells with exponential connected to DC load through a new design chopper is used with fuzzy logic controller. The tracking of maximum power point tracing system standard conditions and variable input is also applied to the photovoltaic cell. The FLC based MPPT is generally faster than the controller based on classical MPPT algorithms and FLC based MPPT converter produce the constant output voltage, current. The fuzzy controller has been improvements against the ripples in steady state. The MPPT fuzzy logic control has much better performance if it compare with other controller at the time of response and stability. With increasing the temperature always a decay in output power. The fuzzy controller has a response almost perfect continuation algorithm while P&O and INC are late and they present some fluctuations. The fuzzy controller has a response almost perfect continuation algorithm while P&O and INC are late and they present some fluctuations. We also note that the fuzzy MPPT controller is faster Structure of the proposed system. The result show that the fuzzy controller following the deposit with less fluctuation.

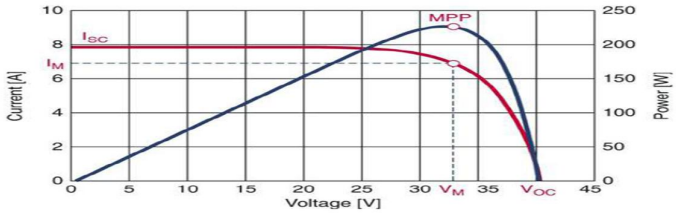

Fig: 7- Solar panel characteristics showing MPP and operating points

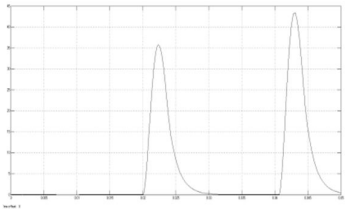

Fig: 8- Power Output of MPPT using P&O Algorithm

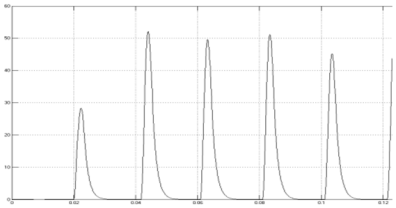

Fig: 9-Power Output of MPPT using Fuzzy Logic

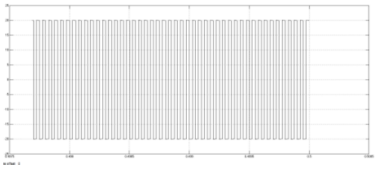

Fig: 10- Output of inverter with DC input

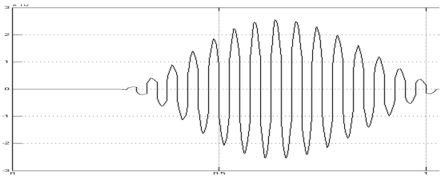

Fig: 11- Output of Solar Power Plant

V. CONCLUSIONS

In this paper modeling and simulation of artificial intelligence based solar power plant and developing renewable energy system are implemented, it is useful for industrial and also for residential applications. The analysis of simulation results has shown on the basis of maximum power point tracking.

- Extracting maximum power from the PV panels with tracking maximum efficiency.
- Splitting the power between the power sources to sustain the efficiency of the system.

Simulation results were obtained by developing a detailed of artificial intelligence based solar power plant model. The most commonly used algorithm in commercial converters, has the potential to be very competitive with other methods. The efficiency of solar power generation depends on both the MPPT control algorithm and also the MPPT circuit. The MPPT control algorithm is usually applied in the DC-DC converter, which is normally used as the MPPT circuit. MPPT using conventional method and using fuzzy logic is to be implemented and inverter is to be connected so that the dc supply is converted into alternating supply which will further be distributed to houses and industries etc.

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