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Distributed Generation Photovoltaic System Based on Fuzzy Logic

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Abstract: ***Most of the Developing Countries in the world have facing the demand of unavoidable power demand. Due to this high demand, we facing the high-power losses and increase of the transmission lines. In our India we are totally based on the thermal & nuclear power plant and it's also going to end in few Years. The continues power demand can cause reduction of the voltage levels and affect the system stability, that causes the failure in power system Network and make the transmission line in the stressed condition. In the current situation we going towards the renewable energy, and it's gaining the attention around the globe. The renewable energy matches the load demand and full-fill it according to the load demand. To step in renewable energy, we have to study it carefully to avoid any unwanted issues occurs in the system and do not make it unstable. The main issue that faces by the consumers is, the solar system gets off during the main supply failure and the total load shifted on the Diesel generator. Due to this Diesel generator get more consumption of diesel and get heavily loaded. To avoid this Heavy load on Diesel Generator we have to use the solar plant during off-grid conditions with the help of smart synchronization between the photovoltaic system and Diesel Generator. Thus, the result of smart synchronization of Photovoltaic system and diesel generation, we get the less load on Diesel generator as compare to the photovoltaic system.***

Keywords: Diesel Generator, Photovoltaic, DG-PV Controller, Fuzzy logy, Anti-islanding

I. INTRODUCTION

As the world population and the standard of living increase, the demand for commercial energy is projected to continue its ascending trend. Energy is the key determinant of the expansion of industrialization, a requirement for social development, and its readiness, as well as the pattern of feeding, plays an important role in sustainable growth. It is recognized and acknowledged that Solar energy will play a crucial role in the future as they are environmentally friendly, easy to use, and is bound to become economically more feasible with increased usage. This paper involves the simulation of DGPV with the help of Fuzzy Logic in MATLAB. Sometimes, electricity can be cut-off due to natural disasters or for maintenance purposes. In that situation, our On-grid solar plant will also get turned OFF as per the Indian Standard of electricity board because outgoing power from the consumer side to the grid when the grid is turned OFF can be hazardous, and for safety reasons, this rule is implemented by the board. The only solution remains to get shifted on the diesel generator until the power supply gets normal. Running the DG for a long time can be costly as it requires fuel for its operation and also the gases produced by the DG can be harmful in nature as it leaves its carbon footprints. Thus, this project aims to use the Solar plant in the off-grid condition with the help of reference voltage from the diesel generator. Meaning the PV can be turned on in off-grid conditions in integration with the DG, with the help of the controller. In this project, we have designed the DGPV controller, Solar plant, and Diesel generator in MATLAB. DGPV controller which is the heart of this system runs on the fuzzy logic which gives the command to all the components. DGPV controller looks after the integration of DG and PV, balancing the load, giving 1st priority to the PV system, and looking after the faults in the system like anti-islanding.

II. LITERATURE SURVEY

A. Photovoltaic

Figure 1: Photovoltaic arrays

The performance of a solar photovoltaic array is needed to produce power efficiently as possible, the power output from the photovoltaic array at a given time step is the function of the panel effectiveness area and the radiation occurrence. The photovoltaic array production power can be found by the resulting equations:

$$P_{pv} = \eta_{pv} \times A \times I_t$$

It is the radiation incident on the tilted surface of the photovoltaic array (W/m2) at that time step, and A is the total photovoltaic array area (m2).

B. Diesel Generator

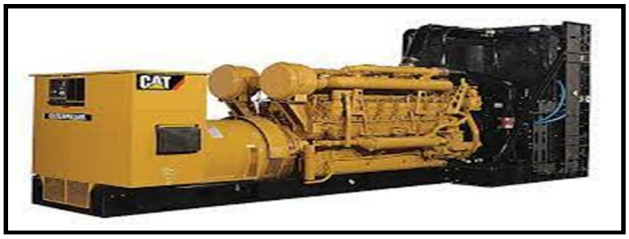

Figure 2: Diesel Generator

A diesel generator is require to supply the load when the generator energy from the photovoltaic array is sunsatisfactory. When the PV is generating a minimum level, the diesel generator as a backup source is switched on to fulfill the demand of the load. If the diesel generator is directly attached to the load, then the rated capacity of the diesel generator must be at least equal to the maximum load. The rating of the diesel generator is given by

$$P_{dgr} = max\left(Peak\ DG\ demand, \frac{Energy\ Demand}{\frac{Hrs}{day} \times Load\ Factor}\right)$$

The fuel consumption of the diesel generator be subjected on the rated power of the generator and the actual power output supplied by it.

C. *Utility Grid*

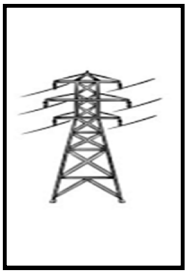

Figure 3: Utility Grid

A utility grid is usually a commercial electric power distribution system that takes electricity from a generating station (e.g., thermal power plants.) and transmits it over a certain distance, then takings the power down to the consumer through a distribution system. The entire system is referred to as the grid.

D. DGPV Controller

Figure 4: DGPV Controller

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DGPV controller is the heart of the system which is based on a fuzzy control system. The controller works on algorithms/logic which is as follows:

1) When the utility grid is ON the DG should be OFF and PV will work as an on-grid system.
2) When the utility grid is OFF the DG should be ON and PV will work as an on-grid system as it gets reference from the DG.
3) When the utility grid is OFF The CB'S at the utility grid should operate and isolate the consumer from the grid to prevent the backflow in the system.
4) The controller should give 1st preference to the renewable source which is PV in our case, meaning the maximum load should be on PV and remaining on DG.
5) In case of fault, the controller should shut down the whole system and island it from other sources immediately.

A fuzzy control system is a control system based on fuzzy logic i.e., a mathematical system that analyses analog input values in terms of logical variables that take continuous values between 0 and 1 in contrast to classical or digital logic, which operates on discrete values of either 0 or 1 (true or false, respectively). DGPV controller is used to controlling the whole DGPV system along with the fault detection by fuzzy logic.

III. SIMULATION

There are three sources of power PV, DG, and the utility grid all the 3 sources are interconnected with the help of the DGPV controller. A PV supplies a dc source to the inverter and the output of the inverter is fed to a controller same as that the output of the DG and the power coming through the utility grid is fed to the controller's input. The load is connected to the controller's output. The controller senses the amount of load and according to that, it adjusts the power flow from the input sources. If the utility grid is on the power is fed from the utility grid and the PV. If the utility grid is off the power is fed from the PV and the diesel generator, and the 1st preference is given to the PV and 2nd to the DG for fuel saving.

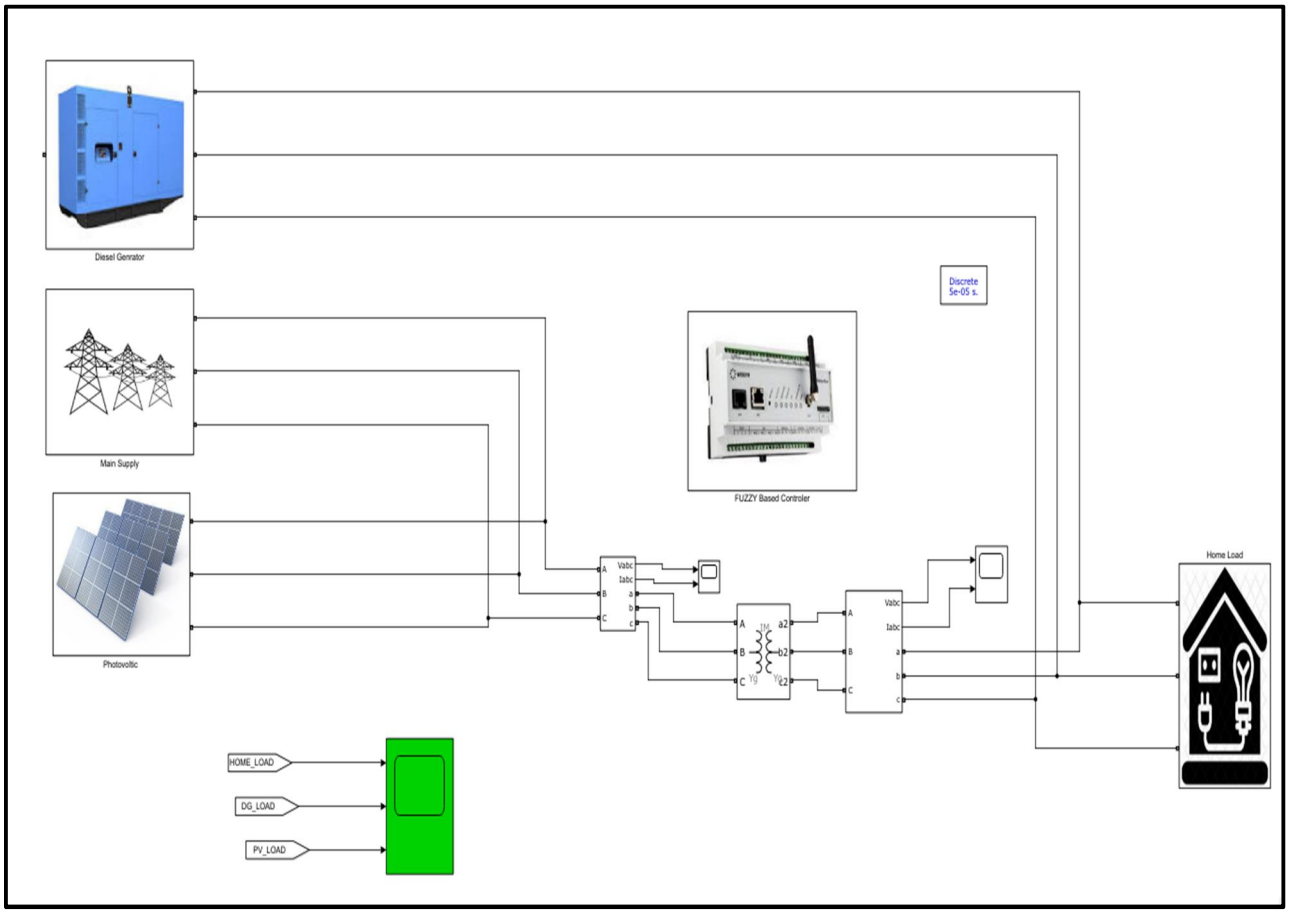

Figure 5: Simulation of DGPV System in MATLAB

IV. RESULT

Figure 6: Waveform of DGPV System (Load, Photovoltaic, Diesel Generator)

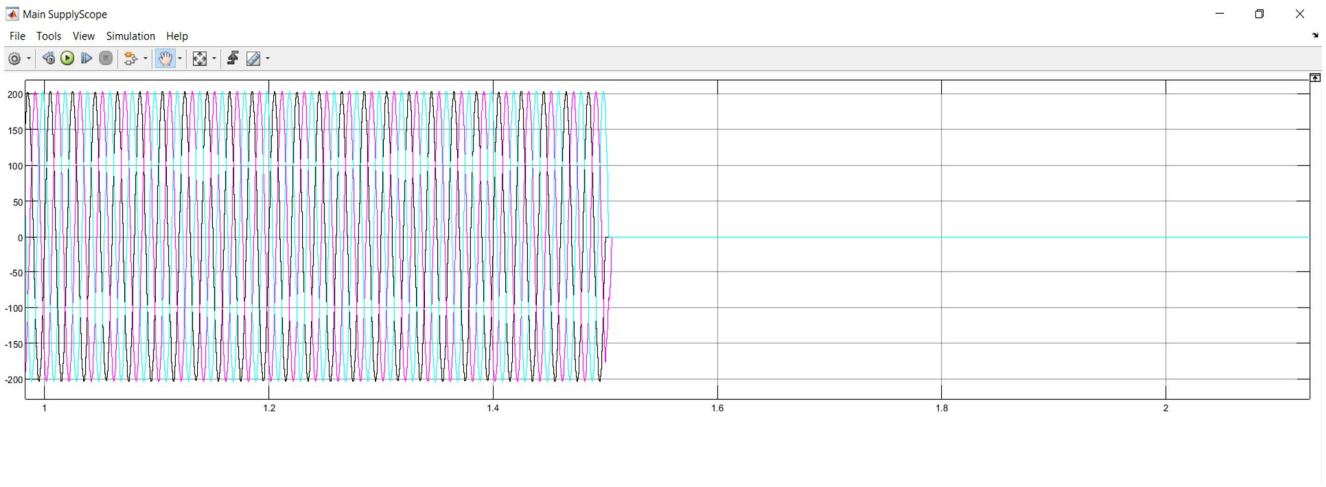

Figure 7: Waveform of Main-Supply

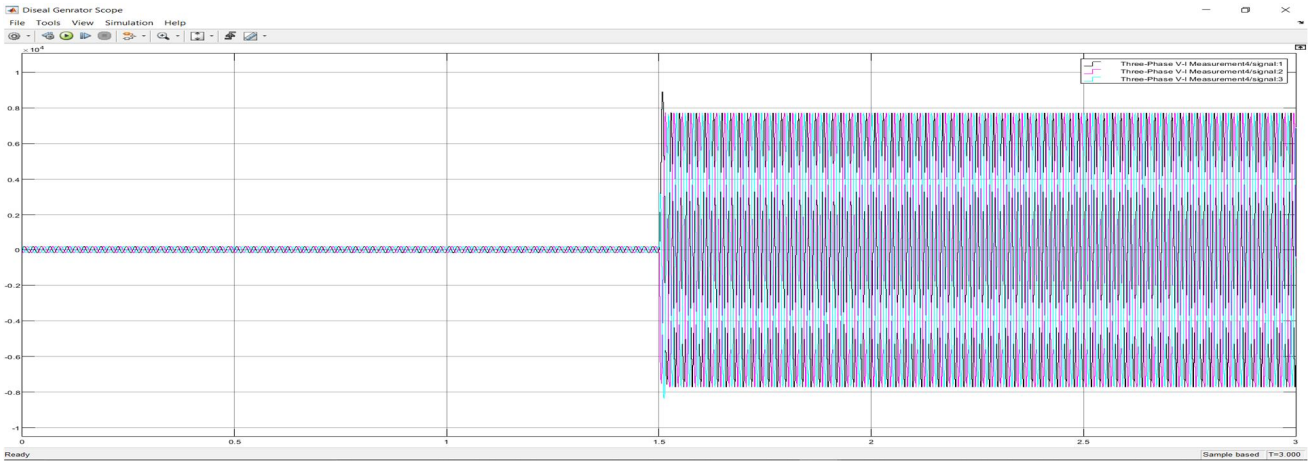

Figure 8 Waveform of Diesel Generator

As we can see in fig. 6, There are various types of graphs present there: -

1) The first graph represents the main load. Which is consumed by the consumer, the load is 200 KW as shown in graph.
2) The Second graph represent the Photovoltaic system that is solar system it generates more than 160 KW.
3) The Third graph represent the diesel generator that's generate more than 200 KVA.

After running the simulation, we get the result.

a) On the load side we have the result. In which at a certain point the breakdown occurs due to the supply failure as well as when the fault occurs in the system. At that movement the load get power from the Photovoltaic and the diesel generator and start the supply of current.
b) In the photovoltaic the current is constant, because of the DG-PV controller. It allows the PV to self-start with the reference of the DG. It gives the maximum generated voltage to the Load side.
c) In the DG (Diesel Generator) is off in the normal condition (When grid is on). At the time of fault or when the Grid Failure, due to sudden drop of the current the diesel Generator start working. And give its produced energy to the load. At the figure 7 and 8, when the grid Failure the DG start at the same time.

Here we prove the Implementation of Fuzzy Logic for fast fault detection and fast clearing

V. CONCLUSION

A solar DG-PV system effectively provides a control mechanism to coordinate between parallel sources of energy in case of a power failure. Smart synchronization between the photovoltaic system and Genset assures greater uptime of the system and up to 50-55% fuel saving.

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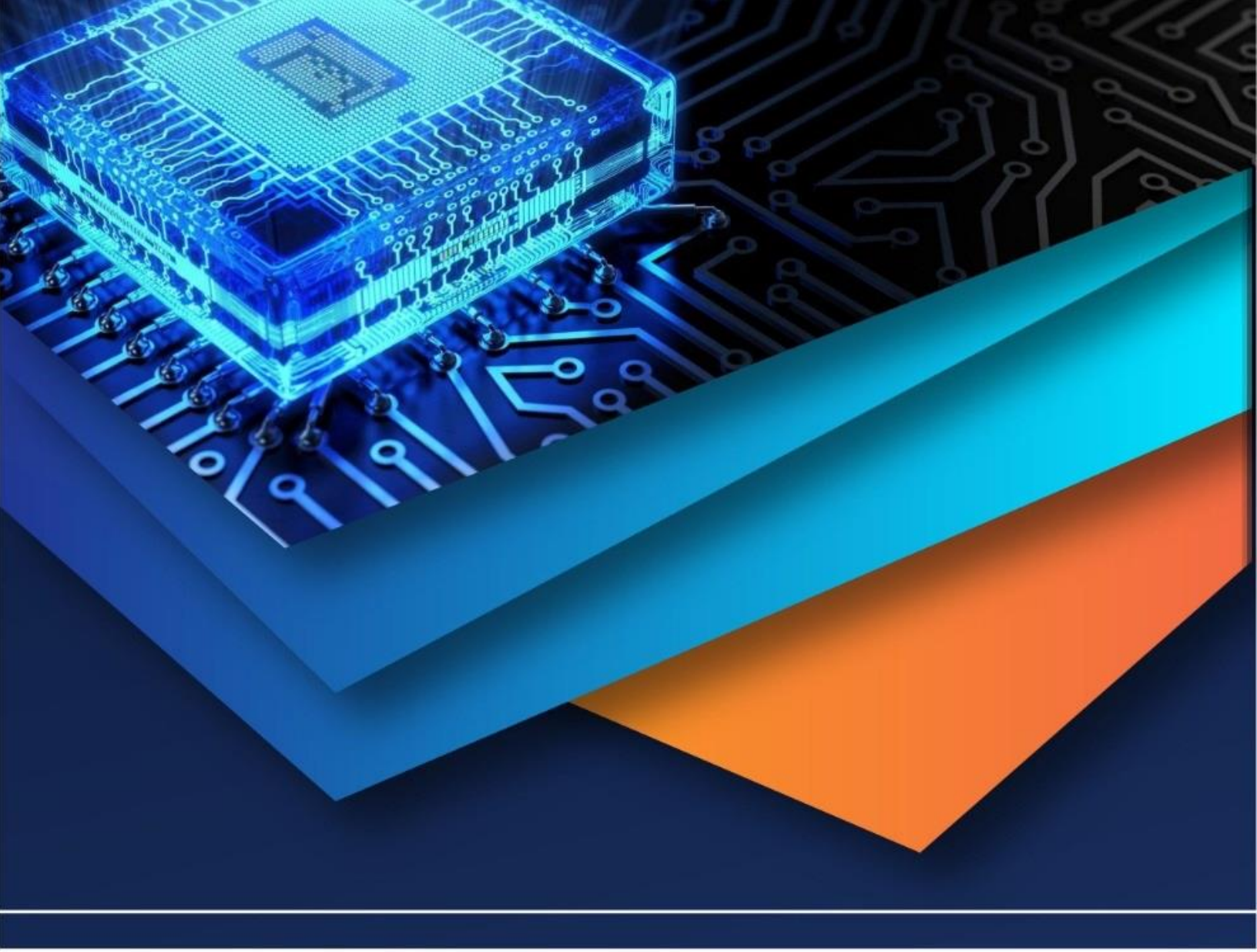

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