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ENHANCEMENT OF POWER QUALITY IN DISTRIBUTED GENERATION RESOURCES USING ANT COLONY OPTIMIZATION

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Abstract—***This paper presents a control strategy for an islanded micro grid to coordinate Hybrid Power Source (HPS) units. Micro grid usually consists of multiple distributed generation units interfaced to the system through power electronic inverters. Usage of power electronic inverters results in harmonic generation and leads to power quality issues. In the proposed method multiple photo voltaic arrays are considered. When PV arrays are partially shaded there is failure in finding global maximum power point. To overcome the inadequacy Ant Colony Optimization (ACO) based Maximum Power Point Tracking (MPPT) scheme is adopted in this work. Using Ant Colony Optimization maximum power point can be tracked and this is given as duty cycle to boost converter to boost voltage. Hence voltage fluctuations can be minimized and there by power quality can be enhanced. The proposed method has been simulated using MATLAB/SIMULINK in power system block set.***

Keywords— ***Power Quality; Fuel Cell (FC; Hybrid Power Source (HPS); Photo Voltaic (PV); Ant Colony Optimization (ACO).***

I. INTRODUCTION

Micro grids aim to provide a solution to alter the conventional power system. A micro grid plays a key role for renewable energy integration and energy management capability improvement. Distributed generation resources include fuel cells, wind, solar, or other energy sources. A micro grid may naturally be subjected to unbalanced conditions due to the presence of single phase loads and/or distributed generation (DG) units. Moreover, the inclusion of nonlinear loads in an islanded micro grid leads to various power quality problems, e.g., distortion of voltage and current. Micro grids have two modes of operation, namely, grid-connected and islanding modes [6]. During islanding mode, storage performs energy balance. Grid-connected mode prevents propagation of the renewable source and load fluctuations to the grid.

In micro grid application, the FC hybrid power system is connected to high-voltage dc bus using high step-up converter, and bidirectional converter. It also includes the FC source and battery source. This requires more components. To overcome this multi cascaded source configuration is studied in [16]. For high power applications, due to technical issues and system reliability, it is preferred to realize unit specifications with series/parallel grouping of smaller units. So a Multi Hybrid Power Conversion System (MHPCS) configuration where the FC/SC hybrid units are paralleled is discussed in [1]. In this paper, a control strategy for voltage control is anticipated to augment the dynamic response of power sharing among the DG units. The photovoltaic (PV) array uses a Maximum Power Point Tracking (MPPT) technique to continuously deliver the maximum power to the load when there are variations in irradiation and temperature.

The disadvantage of PV energy is that the output power depends on weather conditions and cell temperature and it is not available during the night. In order to overcome these drawbacks, alternative sources, such as Proton Exchange Membrane Fuel Cell (PEMFC), should be installed in the hybrid system [7]. A new three-input dc–dc boost converter is proposed in [8]. Moreover the proposed converter includes bidirectional power flow and has simple structure.

In Micro grids using power electronic inverters multiple DG units is interfaced to the system [17]. For high power applications cascaded H - bridge multilevel inverters are preferred [10]. Hybrid Power Sources such as fuel cell and photovoltaics are mostly used as a power source due to their environment friendly characteristics. Because of slow dynamic response of fuel cell and quick load changes, Super Capacitors can be used as storage system [1]. Proposed Hybrid Power Sources improves the transient response and power quality in micro grids under nonlinear and unbalanced loads [5], [11], [15]. Power Quality issues mainly arises due to the use of converter based DG units. In spite of power generation DG units also provides voltage support, flicker mitigation and harmonic compensation. This is described in [3], [4], [9], [12], [13], [14] and [18].

Here the objective is to track maximum power point using ant colony optimization. Integration of Hybrid Power Sources to the DC bus is done through DC - DC converter. Using Ant

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Colony Optimization the duty cycle for boost converter is derived to boost voltage and hence voltage fluctuations can be minimized and power quality can be enhanced.

II. PROPOSED SYSTEM BLOCK DIAGRAM

Fig. 1 shows the block diagram of system. It comprises of Hybrid Power Sources, DC - DC converter, DC capacitor, multilevel inverter and AC load. A hybrid power resource possesses good scalability and more elasticity for power management.

Fig 1 : System Block Diagram

Hybrid power sources include solar arrays and fuel cell. Hybrid power sources such as Fuel Cell and photovoltaic systems are widely used as the main power sources due to their environment friendly characteristics. Each HPS are connected to the dc bus through dc-dc converter. The PV unit enables the FC to obtain an appropriate operating point at which the hydrogen consumption is minimized. DC- DC converter act as boost converter. Multiple PV arrays are used so that maximum power is obtained.

III. PROPOSED TECHNIQUE

In ant colony optimization first colony is built. In this colony voltage and current of solar array are considered. Then target voltage is created. Ants are placed randomly. Ants move in random direction to achieve target voltage. After achieving target voltage it has to come back to colony. Distance between target value and colony is taken as duty cycle and is given to DC-DC converter to boost voltage.

3.1 Ant Colony Optimization

The ant colony algorithm is a met heuristic method which is used in solving tedious optimization problems. This algorithm, was proposed by Dorigo and his collaborators, has been successful and has given rise to large researches. This algorithm is stimulated from the ant's behavior using their individual substances, called pheromones. When the ants explore the network, if an ant finds a good route, pheromone is injected from its body. In this way ants bring shortest path between the nest and food sources. The commercial traveller problem, the quadratic assignment, the sequential scheduling, the Vehicle routing, the routing in the telecommunication network, the graph coloring are various areas where ant colony optimization have been used.

Stochastic nature and adaptivity are the inherent natures of ant colony optimization. The ACO approach represents an optimization problem in a graph whose nodes and arcs represent the decision variables of the optimization problem. Ants build solutions step by step moving inside the graph according to a stochastic decision rule that depends on the one hand, the collective information derived from the environmental change, on the other hand, a heuristic value concerning the outgoing arcs choice quality. In the graph construction process, each ant does its next arc / node choice outgoing according to information stored in the graph, either the pheromone quantity or the heuristic value represent the local travel cost. The relative importance information's depend on the control parameters in transition rule. Once a journey is completed, information about the route quality will be changed.

The algorithm can be characterized by the following steps,

Step1: The optimization problem is formulated as a search problem on a graph.

Step2: A certain number of ants are released onto the graph. Each individual ant traverse the search space to create its solution based on the distributed pheromone trails and local heuristics.

Step3: Based on the solutions found by the ants pheromone trails are updated.

Step4: If predefined stopping conditions are not met, then repeat the first two steps, otherwise, report the best solution found.

Fig. 2 shows the simulation diagram of proposed system. To verify the above design and analysis, a simulation model was developed in Matlab\Simulink. In the simulation, dc bus voltage is set to 560 V. Here four photovoltaics are considered. Each photovoltaic produce different powers due to different

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irradiance levels. As a result voltages of each PV will be different. While taking average of voltage, there is a deviation from dc bus voltage that is 560 V. To maintain constant voltage converters are used. In this simulation boost converters are used so that 560 V can be achieved. Voltage and current of photovoltaic is given as input to Matlab function and power is calculated.

When the irradiance increases, the current and voltage output also increases. Fig. 4 shows dc bus voltage. Initially bus voltage starts from zero. Gradually it rises upto 800 V. By applying optimization technique voltage is maintained 560 V. Fig. 5 shows the battery charging voltage, state of charging. Initially battery discharges and voltage increases. When battery is fully charged voltage decreases and maintains almost 560 V.

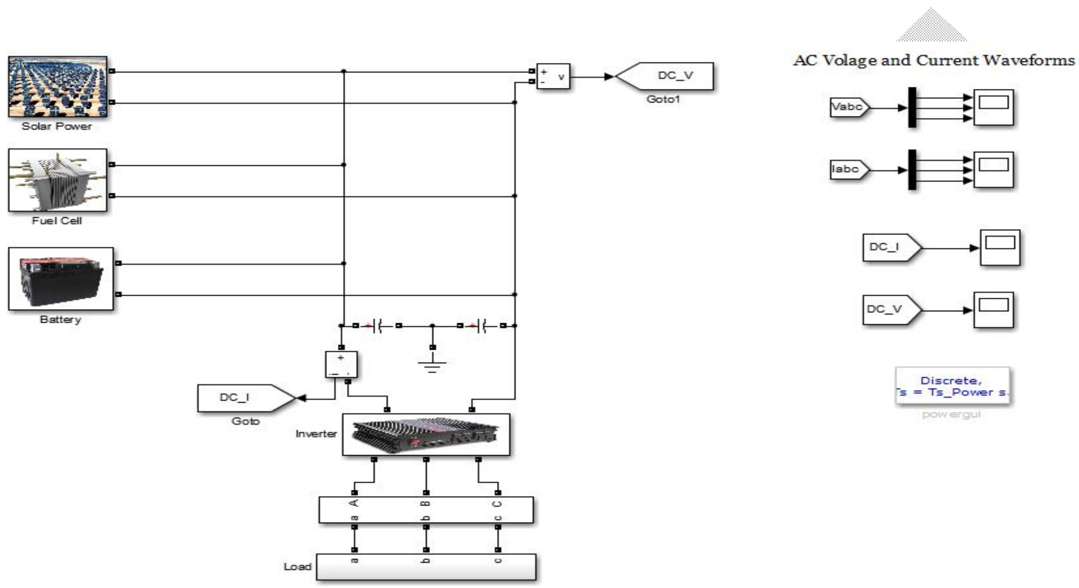

Fig 2 : Simulation Diagram

Since there is voltage variations it is necessary to calculate each power and is labelled as Global1, Global2, Global3, Global4 and this is the global power and it is fed into PV and boost converter.

IV. SIMULATION RESULTS AND DISCUSSION

The following figure shows the simulation results. Fig. 3 shows photovoltaic voltage. As the simulation starts and the load begin draw current from PV, the voltage and current start moving towards the operating values.

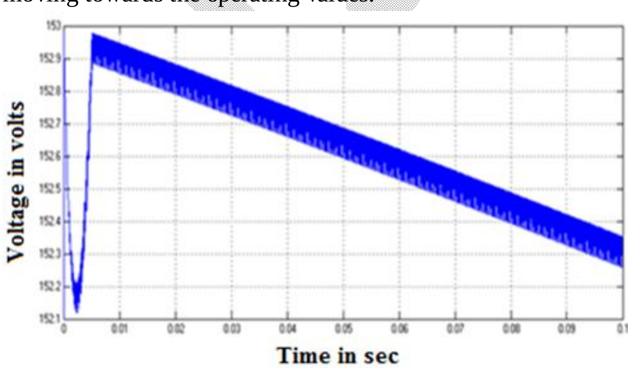

Fig 3 : Photovoltaic Voltage

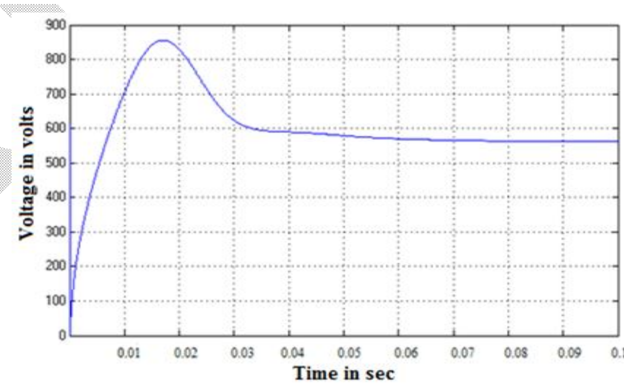

Fig 4 : DC bus Voltage

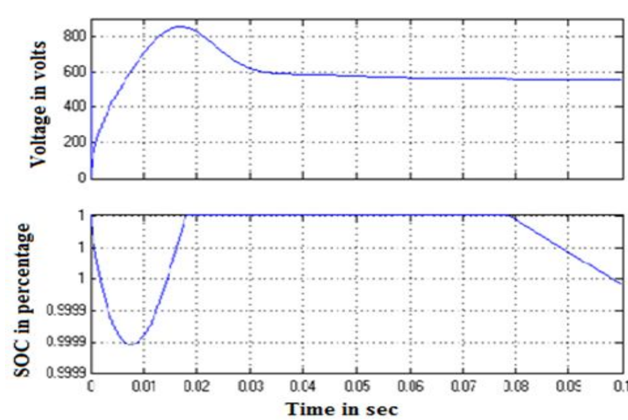

Fig. 5 : Battery Voltage and State of Charge

Fig. 6 shows ant colony optimization output. Using ant colony optimization duty cycle is provided and this is given to boost converter and voltage is doubled.

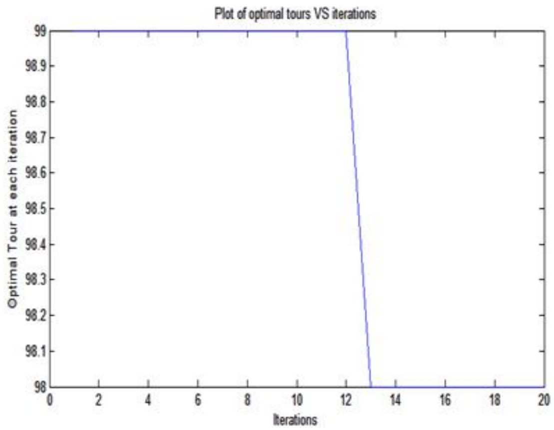

Fig. 6. : Ant Colony Optimization

V. CONCLUSION

In this work bus voltage is maintained constant by using duty cycle that is generated by ant colony optimization. Hybrid power source are connected to dc bus. While connecting to dc bus there is voltage fluctuations which results in power quality problem. So ant colony optimization is utilized to track global maximum power and this is given as duty cycle to boost converter to boost the voltage and minimize voltage fluctuations. Thus bus voltage is maintained constant and quality of power supply is improved.

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