International Research Journal of Innovations in Engineering and Technology (IRJIET)

ISSN (online): 2581-3048

Volume 3, Issue 4, pp 10-16, April-2019

Battery Storage and Demand Power Management for Economic Operation of the Smart Grid System by using Chaotic Improved Honey Bee Mating Optimization

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***Abstract* - A logic based algorithm developed for Battery Storage Power Management and Demand Side Power Management for the Smart Grid. This algorithm enables lower cost operation of the smart grid by utilizing the time of use electricity pricing concept. Applying the Chaotic Improved Honey Bee Mating Optimization to the SSG. The BSPM can strategically handle fluctuation PV production. They can intelligently alternating between absorbing power during high solar irradiation periods and discharging power to the load during peak consumption times. This algorithm used to efficiently managing both BSPM and DSPM. They can increase stability and reliability of the Smart Grid network. In this system electricity demand on the Smart Grid during peak time is reduced providing the balance between supply and demand. BSPM and DSPM in power systems are maintained.**

Keywords: CIHBMO (Chaotic Improved Honey Bee Mating Optimization), Battery Storage Power Management (BSPM), Demand Side Power Management (DSPM).

I. INTRODUCTION

The smart grid is the concept of improve the stability, reliability, efficiency and quality to a service of traditional power system. In this system they focuses on integrating information communication technologies (ICT) and Advanced Metering Infrastructure (AMI) in current power grids to enable bidirectional, automated and intelligent interaction among all the system components. Then the conventional power grid, in which the consumers are considered as passive consumption points, smart grids treat that the end users as dynamic entities, which they participate in a grid operations and affect programs implemented throughout the system process. Then the smart grid implementation to enables a electric power to be a generation, transmission, distribution process to the consumer in a reliable and efficient manner with the high quality and environmental friendly. Then the managing the power to demand and supply process to the consumer.

The demand side management (DSM) process has been employed to manage the load shaping and end users consumption behavior and to provide inelastic consumers with the flexibility in their electric energy consumption. These processes are used to be achieving a predetermined target and improving consumer satisfaction and then the overall operation efficiency and reliability of the power system process. This integrating renewable energy resources and emerging technological appliances (e.g., PHEV), and then the reducing the total system peak to-average load demand (PAS) as well as the cost will be reduce to the supplying energy. From the perspective of the utility company (energy provider), then the DSM helps to reducing the need to construct new fossil fuel of the power plants to be compensate for the energy shortage caused by rising energy demand. However, the utility company has to provide some incentives to assure that the consumers follow. We mention here two examples of the DSM program implementations. One of the example is to be in direct load control (DLC) programs offer that the rebates and then financial incentives. The other example of related to incentive based programs such as a real time pricing and time of use pricing.

Among the various RES technologies of photovoltaic (PV) technology is to rapidly developing the strong market presence and then decrease the cost has established PV energy systems as viable and economical solution for the residential and then commercial applications. The dependence on a sun exposure makes the PV system reliant of the Battery Energy Storage (BES) elements, in order to be distributing harvested solar

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energy around the clock. In this context, Lithium-ion (Li-ion) technology has been emerged as high power and the high energy density solution compared to the traditional lead-acid batteries. Regardless of the battery chemistry used and the energy systems comprising PV and BES require smart power converters designed with the integrated advanced control features for power management.

II. DISTRIBUTED GENERATION

Distributed generation (or DG) generally refers to the small-scale (typically 1 kW – 50 MW) of electric power generators that produce electricity at an site close to the customers or that are tied to an electric distribution system. Distributed generators include, but it is not able to limited the synchronous generators, induction generators, reciprocating engines, micro turbines (combustion turbines that run on high-energy fossil fuels such as oil, propane, natural gas, gasoline or diesel)then it combustion gas turbines, fuel cells, solar photovoltaic and wind turbines.

Applications of DG System

There are many reasons to a customer may choose to be install a distributed generator. DG can be used as generate a customer's entire electricity supply for a peak shaving (generating a portion of a customer's electricity onsite to reduce the amount of the electricity purchased during the peak price periods) for standby or emergency generation (as a backup to the Wires Owner's power supply) as a green power source (using the renewable technology) or to be increased reliability. In some of remote locations, DG can be less costly as it eliminates they needs for expensive construction of distribution and transmission lines.

III. PROPOSED SYSTEM

In this proposed system, battery storage power management and demand side power management using chaotic improved honey bee mating optimization (CIHBMO). The purpose of the algorithm is for economic operation, reducing the price of electricity consumption by using variable TOU pricing. The compensation of instantaneous variations in the reference currents in ac-side of the interfaced converter has been properly considered. The control strategies empower to manage a DSPM and BSPM following peak and off peak times.

a) Functional Diagram

Detailed functional diagram for the proposed DG resources system. It consists of two DG sources namely PV Cell, EB system. Proposed systems contains mainly PV array, battery, MPPT and boost converter, heavy load and light load system.

The PV inverter is designed to operate in grid feeding mode. The main controller is designed to emulate the converter into an ideal current-controlled source, with applicability in utility-grid interactive and off-grid or islanded mode.

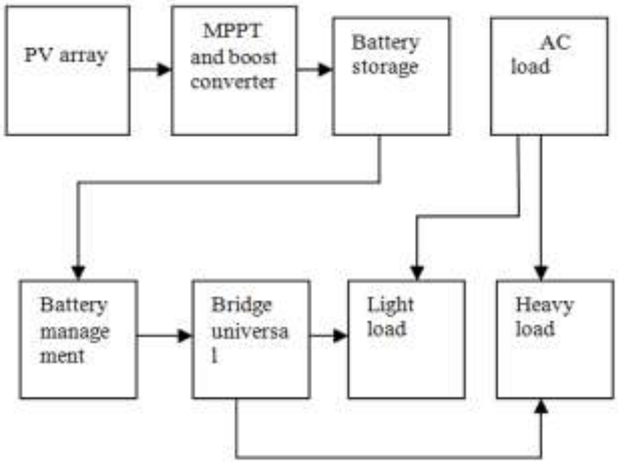

Figure 1: Functional Diagram of Proposed System

b) Elements of the System

- DG sources – PV panel, EB system
- Incremental Conductance MPPT Algorithm
- Boost Converter – to boost DC voltage from PV array
- Battery management system
- Battery storage system
- Ideal switch
- Breaker
- Bridge universal
- PWM generator
- Voltage and current measurement

c) DG Units

Distributed generation also known as distributed generation, on site generation(OSG) or district/decentralized energy is generated or stored by a variety of small, grid-connected devices referred to as distributed energy resources (DER) or distributed energy resource systems. In this project, there are two sources which are used as distributed generation.

d) Solar Energy

Energy in the sunlight is converted into electrical energy by using photo voltaic cell. The photons in the sunlight impact in the semiconductor surface to produce free electrons. The electrical potential developed between two dissimilar

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materials when their common junction is illuminated with radiation of photon. The photovoltaic cell, thus, converts light directly into electricity.

e) The PV Cell

When the light is absorbed by the junction, then energy of the absorbed photons is transferred to the electron system of the material, resulting in the creation of charge carriers that are separated at the junction. The charge carriers may be electron-ion pairs in a liquid electrolyte or electron hole pairs in a solid semiconducting material. The charge carriers in the junction region create a potential gradient, get accelerate under the electric field and circulate as the current through an external circuit.

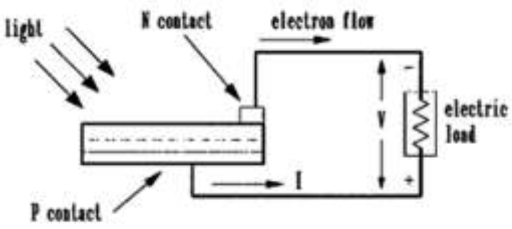

Figure 2: The Photo Voltaic Effect

IV. SIMULATION MODEL

a) PV Array

Photovoltaic cell is the basic unit of the system where the photovoltaic effect is utilized to produce electricity from light energy.

When semiconductor materials are exposed to light, the some of the photons of light ray are absorbed by the semiconductor crystal which causes a significant number of free electrons in the crystal.

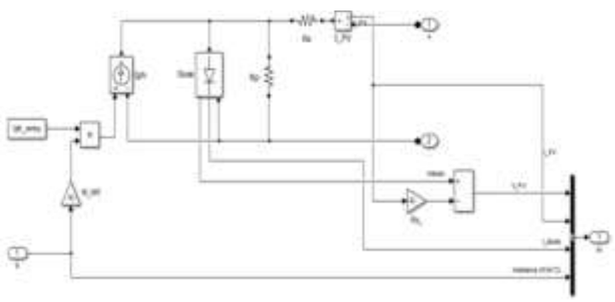

Figure 3: Simulink model of PV array

b) MPPT Technique

Maximum power point tracking (MPPT) is a techniques used commonly with photovoltaic solar system to maximum power extraction under all Condition. Maximum power point tracking (MPPT) is a technique that grid connected inverters, solar battery chargers and similar devices use to get the maximum possible power from one or more photovoltaic modules.

In the incremental conductance method, the controller measures incremental changes in PV array current and voltage to predict the effect of a voltage change. This method requires more computation in the controller, but can track changing conditions.

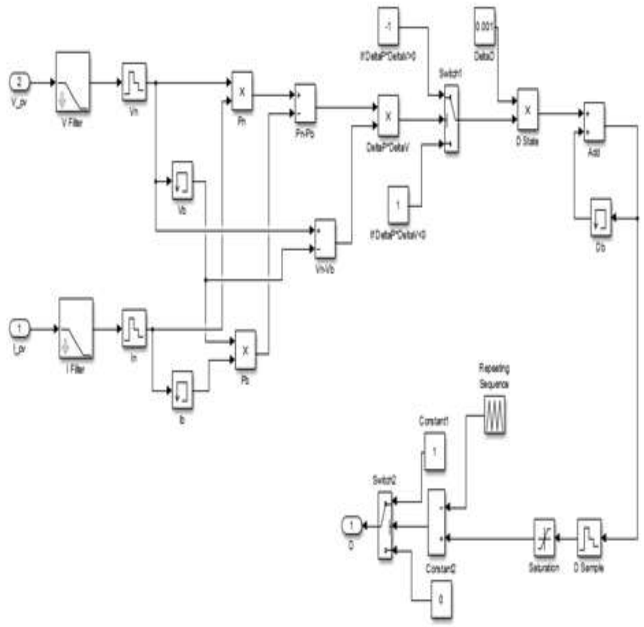

Figure 4: Simulink model for MPPT technique

c) Battery Management System

A complete integrated BMS prototype was developed that controls the charging and discharging of a lithium ion battery from a PV generator. The BSM incorporate a series solar regulator and performs temperature compensated charging.

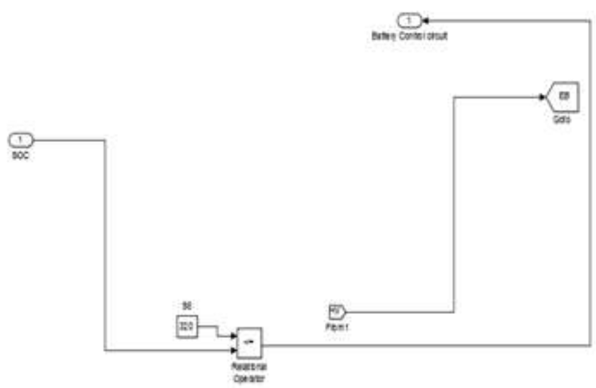

Figure 5: Simulink model of battery management system

International Research Journal of Innovations in Engineering and Technology (IRJIET)

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d) Diode

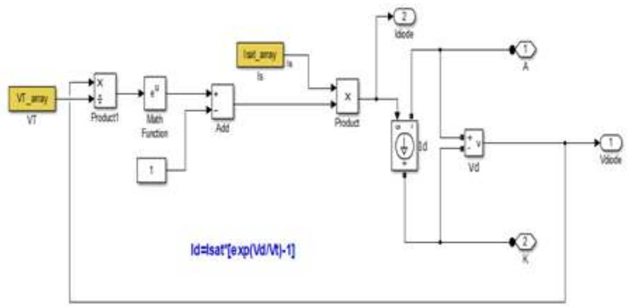

Figure 6: Simulink model for diode

e) Subsystem

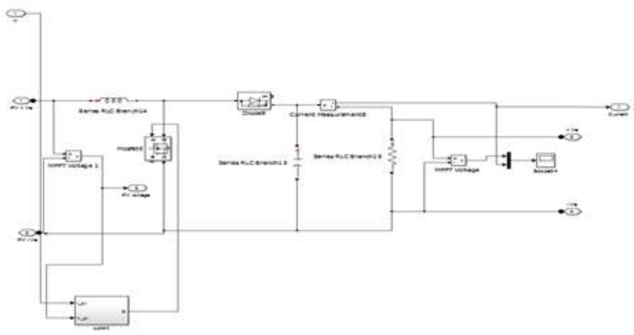

Figure 7: Simulink model of subsystem

f) Battery Storage

Energy storage is the capture of energy produced at one time for use at a later time. A device that stores energy is generally called accumulator or battery energy cost in multiple form including radiation, chemical, gravitational potential, electric potential, electricity, elevated temperature, and kinetic.

Energy storage involves converting energy from forms that difficult to store to more conveniently or economically storable forms. Some technology provides short term energy storage, while other can endure for much longer. Bulk energy store is currently dominated by hydroelectric dams, both conventional as well as pumped.

Figure 8: Simulink model for battery storage

V. OVERALL SIMULATION

In this system Chaotic Improved Honey Bee Mating Optimization algorithm is to maintaining the BSPM and DSPM. The smart grid is a novel concept that was introduced to improve the stability, reliability, efficiency, and quality of service of the traditional power system.), the DSM helps reducing the need to construct new fossil fuel power plants to compensate for the energy shortage caused by the rising energy demand.

PV energy systems as viable and economical solution for residential and commercial applications.

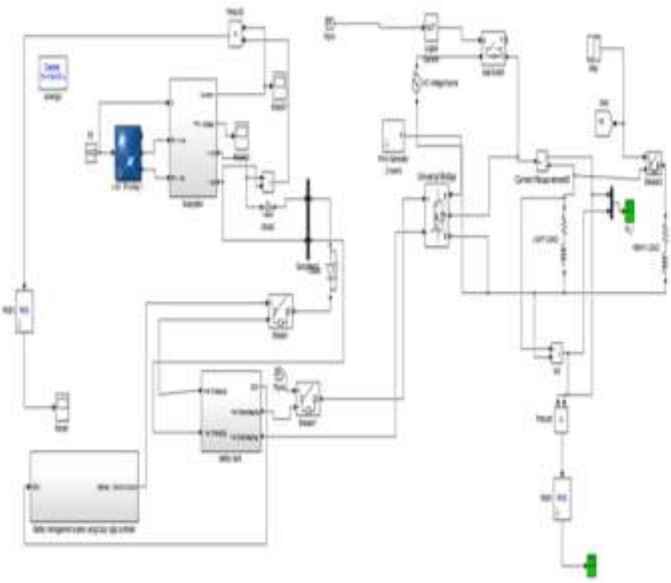

Figure 9: Simulink implementation of Proposed System

a) Simulation Results

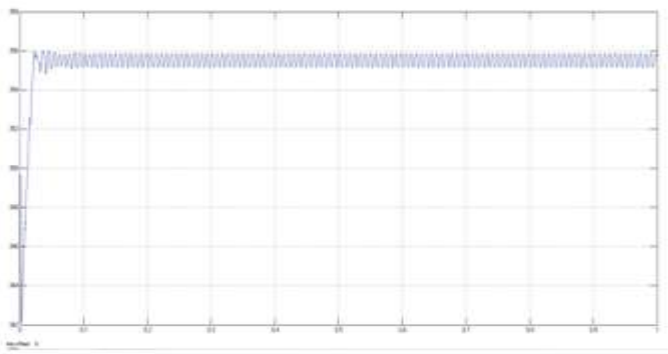

Figure 10: Voltage waveform of PV system

The grid connected PV system is electricity generating solar PV power system. MMPT techniques are used to boost up the output voltage and gives constant voltage. The PV output voltage is constant and free from harmonics disturbance.

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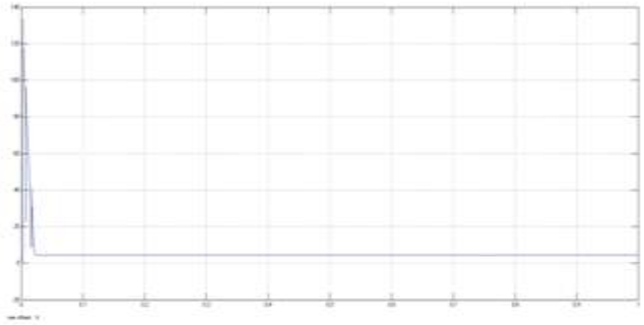

Figure 11: Voltage waveform for subsystem

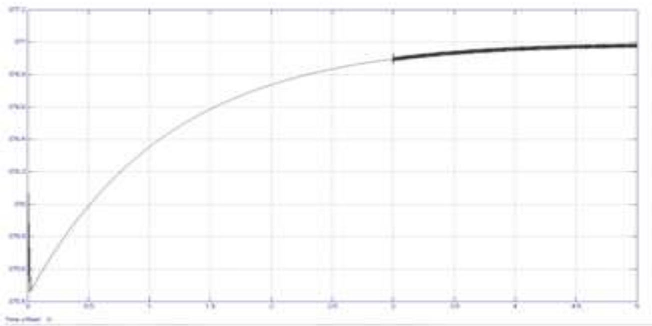

Figure 12: waveform of batter bank

Battery bank for the charge controller such as standby generator along with a battery charge .To avoid the damage to the load and produce pure DC – DC voltage .Battery in PV system for charging and discharging hundreds or thousands of times.

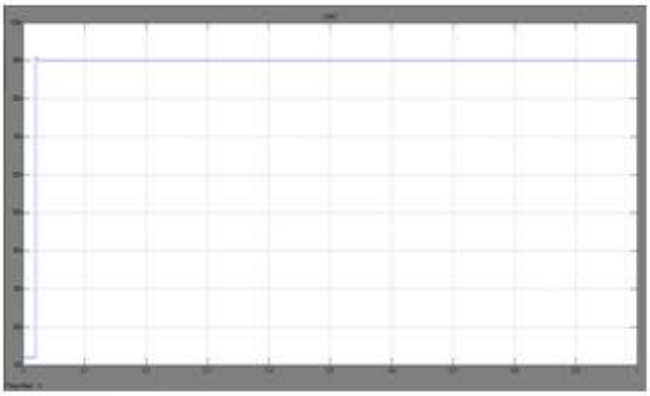

Figure 13: Waveform for light load

A grid connected PV power system is electricity generating solar PV system connected to the grid .the PV output voltage is given to the light load purpose. They can handle fluctuating PV protection output voltage by using of CIHBMO algorithm .to improve the efficiency and reducing the cost of electricity. Electricity demand on the Smart Grid during peak time is reduced providing the balance between supply and demand.

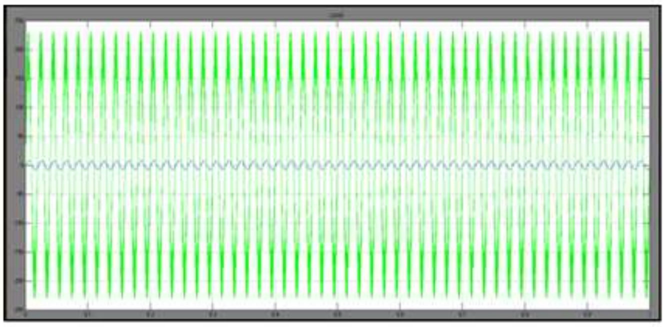

Figure 14: Waveform for heavy load

A grid connected PV power system is electricity generating solar PV system connected to the grid. The PV output voltage is given to the light load purpose. At the time of less power in the grid it can used power from EB system.

The output voltage waveform is maintaining constant power to using the algorithm .To improve the efficiency of the system to balancing the supply side and demand side power management. Implement a simulation model for a Battery Storage Power Management (BSPM) and Demand Side Power Management (DSPM) using chaotic improved honey bee mating optimization (CIHBMO) algorithm.

VI. CONCLUSION

The proposed an improved version of HBMO algorithm combining with a chaotic local search to solve the ED problems. The main objective of the ED problem is to determine the optimal combination of power outputs for all generating units that minimizes the total fuel cost while satisfying load demand and operating constraints. In the paper, in order to make better the performance of algorithm and to enrich the searching behavior we incorporate the chaotic local search (CLS) into improved HBMO in which the mating process has been improved. To validate the proposed CIHBMO, it is tested on three test systems having non-convex solution spaces. The results of the proposed method and those of the previous approaches are compared. The outcome of the comparisons shows the effectiveness of the CIHBMO algorithm in terms of solution quality, convergence, robustness and consistency.

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ISSN (online): 2581-3048
Volume 3, Issue 4, pp 10-16, April-2019

Citation of this article:

Dr.N.Mohanapriyaa, K.Thamaraiselvi, P.Madhumathi, "Battery Storage and Demand Power Management for Economic Operation of the Smart Grid System by using Chaotic Improved Honey Bee Mating Optimization" Published in *International Research Journal of Innovations in Engineering and Technology (IRJIET)*, Volume 3, Issue 4, pp 10-16, April 2019.

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