

# Impact of Renewable Generating Unit on Load Frequency Control in Multi-Area Power System Network under Deregulated Environment

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**Abstract:** Modern power systems would like a lot of intelligence and adaptability to manage and regulate the generation load equity from consequent severe perturbation because of appearing of sustainable energy sources. This complication is changing into a lot of important these days as a result of increasing variety of micro-grids (MGs). MGs typically use renewable energies in electrical production those varies spontaneously. So, variation and unpredictability in power systems becomes the traditional controllers to be less competent to keep a proper load frequency control (LFC) achievement for a ample spectrum of managing condition. In this paper, a hybrid power system is established between renewable and non-renewable generating units. A multi-area LFC network with integration of wind system has been planned. So, alongside with fluctuation in load, renewable energy sources RESs have a prejudicious response on system frequency. In this research paper, Author has represented the impact of RESs like wind generation plant to traditional energy sources for the betterment of load frequency control in which PID controllers are used for LFC and Binary Moth Flame optimizer (BMFO) is used for optimisation of controller parameters.

**Keywords:** Wind Technology (WT), Load Frequency Control, Hybrid Power System.

## 1. INTRODUCTION

The main purpose of a power system is to get constant supply to the customers with better quality of power. The generated power demand must be equilibrium. There are two basic position in which controlled power can be achieved: reactive balance of power and real power. Every environment is interconnected governor area, the arrangement regularity as well as interconnected tie-line can be kept constant through AGC[1]. The feedback control specified to generator is to control the system as it affects the output electrical power. So that the planned electrical power can be delivered to the customers. With the help of AGC, tie-lines and power flow can be audited. By calculating the net change in power generation and the change in position of the generators within the area so that average of the ACE (Area Control Error) can be minimised at a low value. The controlled output of the AGC is generally known as ACE[1]. When the ACE is set to zero with the help of AGC then, both frequency and tie-line errors can easily be minimised to zero.

Objectives of the work is:

- Study of the system performance
- Controlling parameters of gravitational search algorithm (GSA)
- Exhibit advantages of GSA over DE (Differential Evolution), BFOA (Bacteria Foraging Optimization Algorithm), GA (Genetic Algorithm)
- To depict the merits of the improved controller structure and aim is to increase performance of power system.

Electrical energy is key source for every electrical equipment to run and there are harmful effects to generate required electrical power, such as emission of carbon dioxide. The demand of the renewable energy sources has become more popular and clean energy can be produced through wind, hydro, biomass, solar and geothermal, which has globally increased[2]. With the help of the renewable energy sources, air pollution problems can be solved, due to the occasional output power produces the new challenges in power systems. The renewable energy sources have great impact on system operation that can't be unnoticed.

## 2. RENEWABLE ENERGY SOURCES (REs)

In REs, wind turbine is the main source to create the electrical energy from wind. This type of high generation requires additional courtesy. There are two categories that divides wind turbine: variable and fixed speed. With the help of Induction generator (IG), a fixed speed can be achieved which is directly attached to grid, this can be termed as motionless Wind Turbine. Adjustable speed uses either Permanent Magnet synchronous Generator or Doubly Fed Induction Generator[1]. DFIG has two connections which is stator and rotor, in which stator is attached to grid and rotor is attached partially rated converters. Variable speed wind turbines use to allow wind turbine to adjust output power that depends on wind flow speed. Variable type wind turbines can be used in a large variety of wind farms. VSWT has lot of features that attracts in control grids. The VSWT has a benefit of that it maintains the amplitude and frequency of the output voltage. At the common coupling point, it can control the voltage level and remain power factor to unity. The maximum power at variable speed of wind can be produced through VSWT wind generator[3].

It has high capacity in which they must be probed like predictable power source because they can be used to contribute voltage and reactive power, frequency balance and control, power system stability increment, harmonic reduction, etc. With the occasional characteristics of wind energy, active and reactive power control can directly be controlled. It is mandatory to control the frequency in wind farms. There are three levels of frequency levels in wind farms: primary, secondary and initial control[4].

Imbalance in frequency can occurred due to the load and the generated power through generators. This frequency nonconformity unswervingly affects the environmental operations efficiency and security by apparatus damage, overcapacity and reduction in load in broadcast appearances, and sparking in defence strategies[5].

## 3. AUTOMATIC GENERATION CONTROL (AGC)

AGC is the exploit to control frequency of generation units. Secondary control, which can be termed as load frequency control (LFC), the foremost purpose of this system, system frequency can be controlled by operating manually and power generation. Swiftness governor of turbine in generation elements directly proportional to frequency. Rotational power and mechanical power directly proportional to frequency generated in electrical network. Governor of generator detects issues, which can be modified through valve locus to regulate the fuel volume and manage the mechanical output authority to keep a track on load and keep the frequency near the satisfied value[6].

Power interchange and frequency control can be controlled through AGC systems, as well as optimal economic dispatch. The wind energy can be considered as satisfactory contribution to the AGC. The concert is mainly reliant on the wind direction. The unit which controls the generation is mainly affect the control strategy, like intelligent control algorithm, robust control methods and efficient controller in wind turbine[7].

The major function of the AGC is the contribution of the wind farms. There are diverse control approaches like model prediction, optimization, and smart approaches and these methods coordinated with additional campaigns like flexible AC transmission systems (FACTS), energy storage units and generation units[8].

The main aim of this paper:

- (1) Frequency deviation of power system can be studied through wind farm contribution.
- (2) Wind farm application implementation in AGC.
- (3) Different penetration effects of wind farms in frequency deviation in power system.

## 4. LOAD FREQUENCY CONTROL (LFC)

LFC is main aspect of controlling problems arising in interconnected power systems. There are two important aspects in load frequency control: keeping the frequency in a specified limit in every area and maintain tie-line power in inter area power exchange within specified value. LFC is taking advantages for better controlling the electrical power systems[9].

Smart grid network depends on technology for implementing the system architecture in which electrical components worked through IP network. Smart grid contains transmission, generation, distribution and end user. Every node connects with each other and communicate through optimizing the system performance with reducing the risks. In a smart grid network, smart meters and smooth technical purposes transfers the data of vigour feeding and burden parameters to dispatch centre[10]. This facts is initially use for load distribution to remove the backouts which caused by overloading of the system and thereafter it saves the cost happened due to damage equipment.

When there is an increment or decrement in load then system frequency will change according to the load, AGC provides a benefit to the electrical system that whenever there is a increment or decrement in generation units then it will send a control signal to the generator unit to balance the system from varying load. Maintaining the same balance all the time is not possible but AGC gives the best possible solutions so that it can be controlled during the emergency situations. The problems arising in AGC can be solved through control theory. The problems happened due to controlling structure and optimization[11].

## 5. SIMULINK MODEL

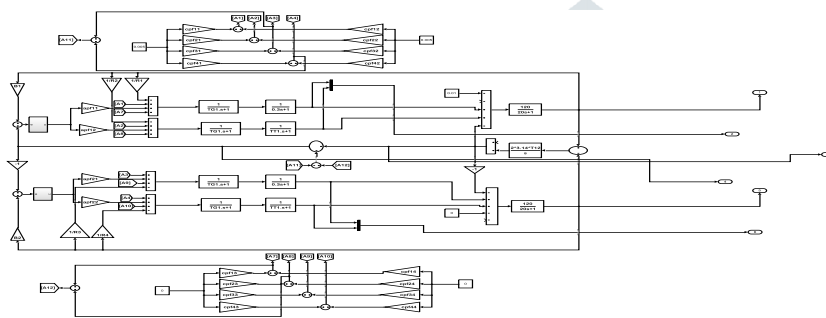
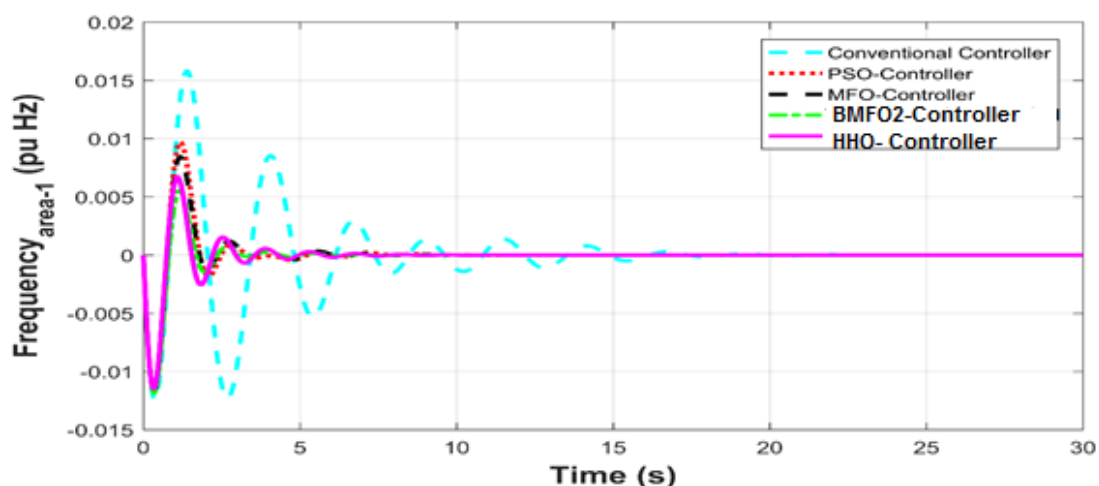


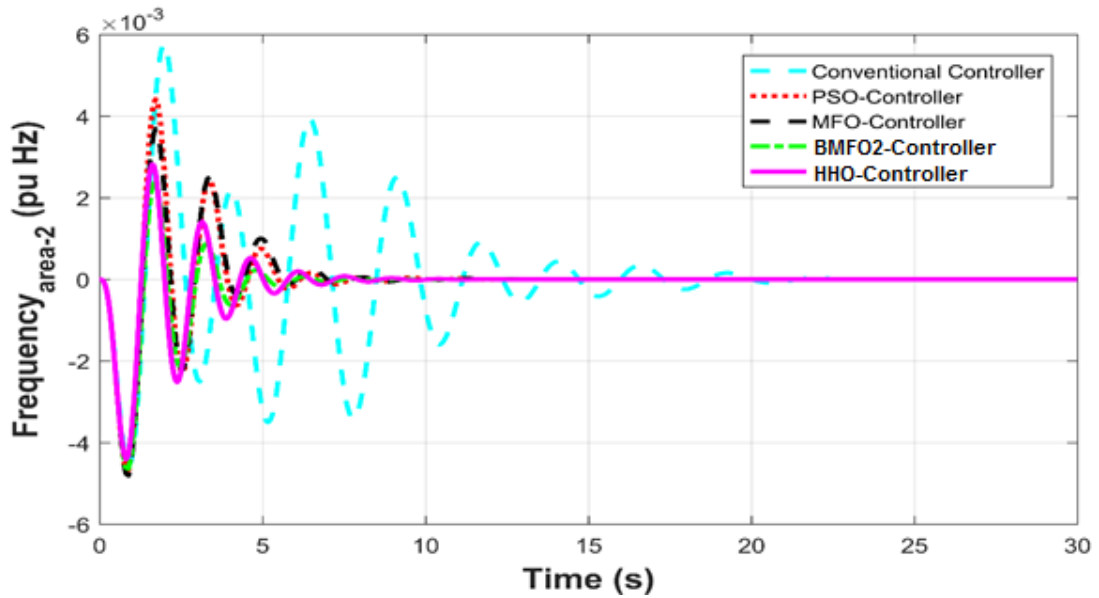
Fig. 1 Simulink Model of Multi area Hydro, Thermal and Wind Energy System

## 6. RESULT AND DISCUSSION

Reliable power system operation requires an ongoing balancing of supply and demand in accordance with established operating criteria.as results are shown in Fig.: 2- Fig.: 4. with respect to deviation in frequency and tie-line with the help of various controllers.

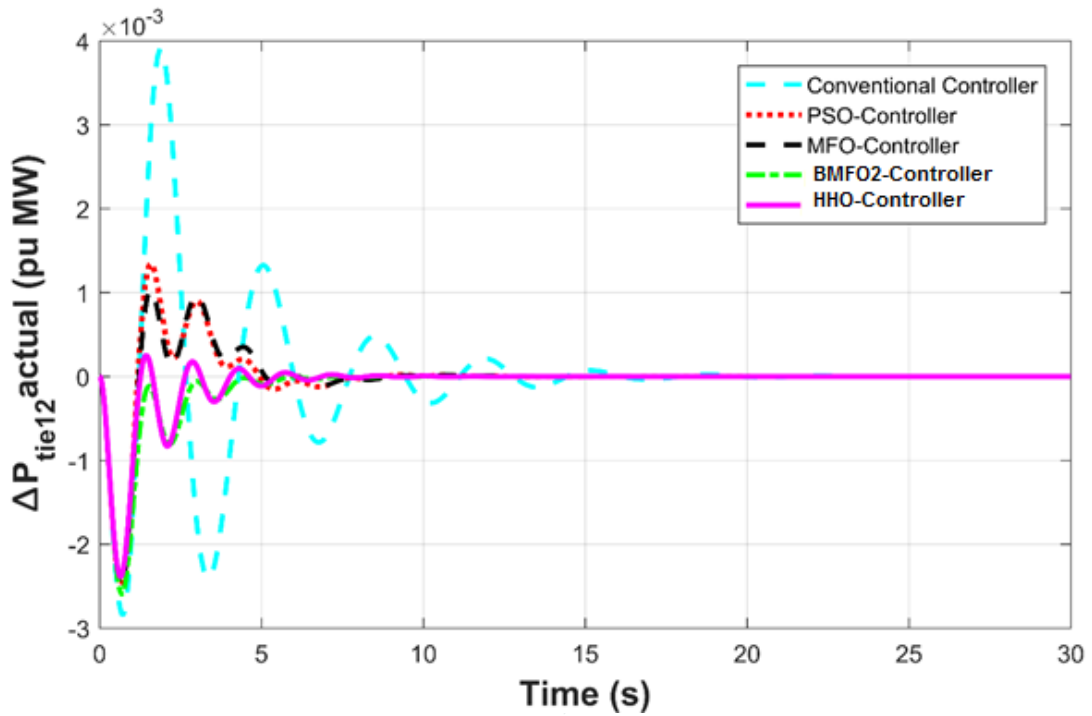


(a)

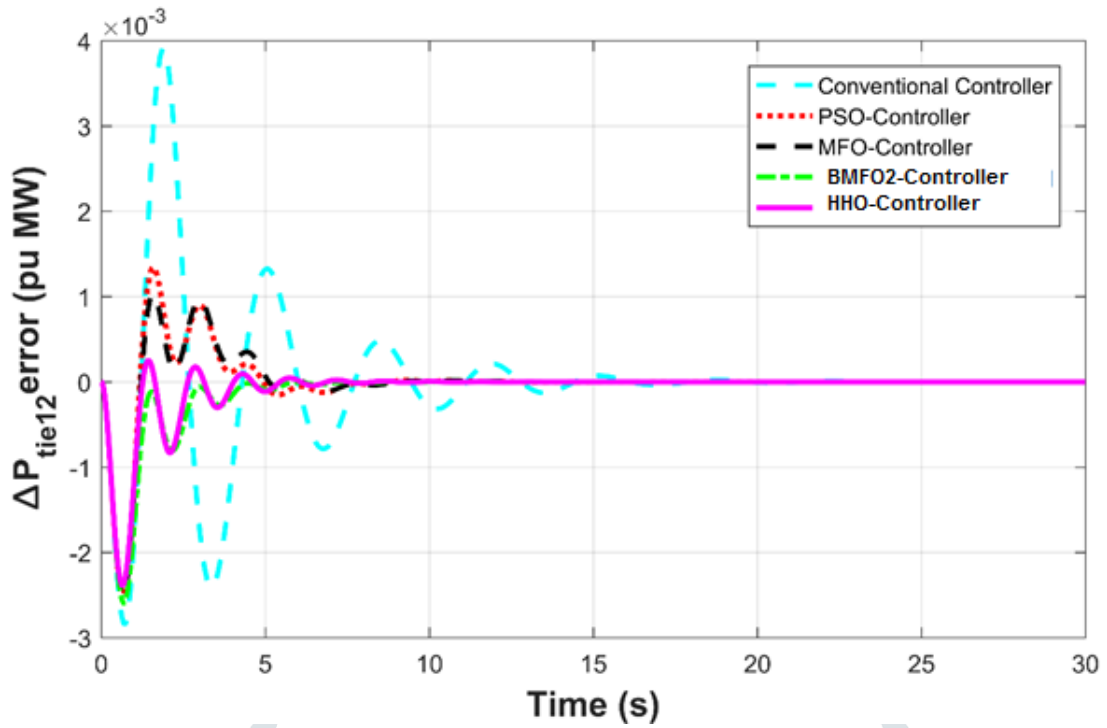


(b)

Fig. 2 (a)-(b): Deviation in Frequency for different Areas

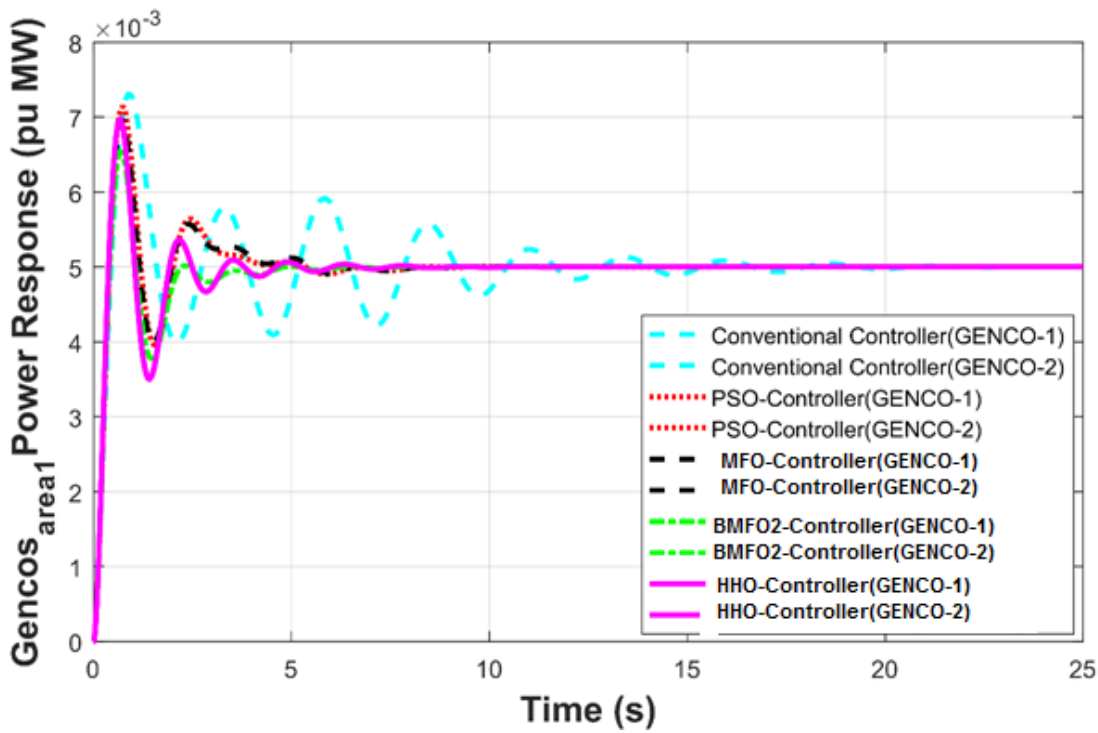


(a)

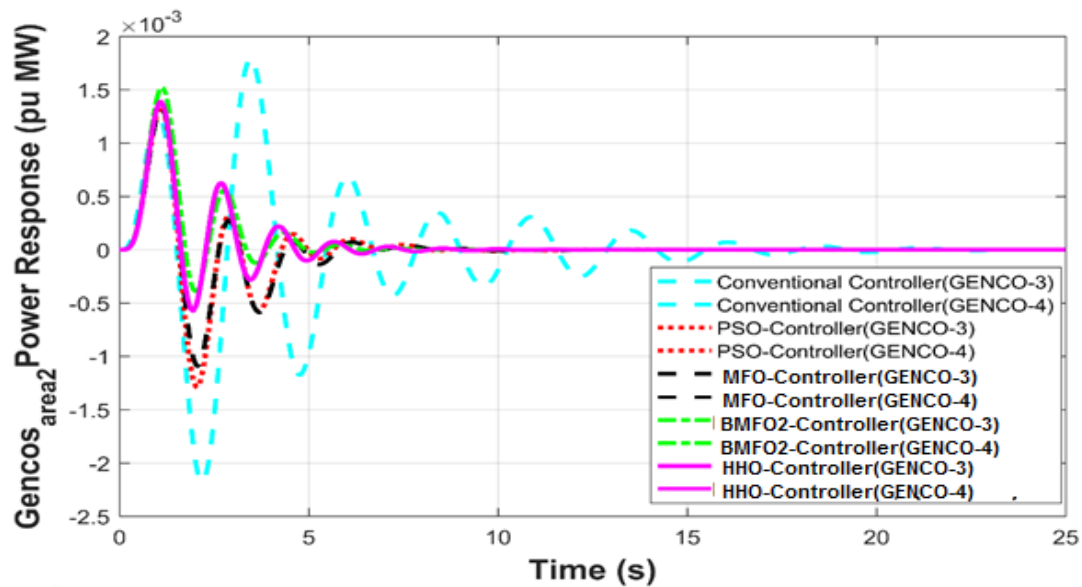


(b)

Fig. 3 (a)-(b): Deviation in tie-line power



(a)



(b)

**Fig. 4(a)-(b):** Deviation in Generation of energy in two areas

## 7. CONCLUSION

In an electric system, during its life cycle, exists in four ways: preventive, normal, restorative and emergency. The operation describes about the frequency deviation and voltage variations. When the system is in balance state between load and generation then it can be termed as normal state[2]. The main aim control unit is to keep the power system in normal condition. It is normal that frequency and voltage deviation will arise due to the imbalance in supply power and receiving electric power. Most of the problems arises due to the overload of power system which results in mismatching of load and generation. AGC gives the optimized methods to overcome these problems which controls the generation to best fit with load[12]. In smart grid, AGC is used in software components and very liable for regulating the power system generation to reduce frequency variations.

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