Control Based on Multi-agent System for Distributed Generation

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Abstract— Islanded microgrid is an independent micro power system. The system has different kinds of distributed generations with different characteristics. Frequency & Voltage stability of microgrids under islanded operation attracts particular attention recently. The islanded microgrid makes its frequence & Voltage control more difficult than the conventional grids. This presents a multi-agent based frequency & Voltage control approach for islanded microgrid and discusses the characteristics of agents. A new cooperative frequency & Voltage control strategy based on centralized multi-agent system (CMAS) is proposed in this study.On This strategy, agents sent data and furthermore each component has its own to center operating decisions (MGCC). After deciding on the information, they are returned. Frequency & Voltage control strategies include primary and secondary frequency control and disposal of multi-stage load in which this study will also provide a method and algorithm for load shedding based fuzzy method.This could also be a big problem for the performance of micro-grid in times of disaster.The simulation results show the promising performance of the proposed structure of the controller based on multi agent systems.

I. Introduction

The electric grid is evolving toward what has been defined as the "smart grid paradigm".[1]. The development of communication infrastructures provides power electronics interfaces with the ability to control complex power systems in efficient and scalable ways and in real time. Multi-agent systems (MAS) are based on distributing information and computing algorithms for complex networks, and are an excellent technological solution for this application.This paper focuses on applications of MAS in power systems and describes how they can be used with other artificial intelligence techniques in order to make the grid smarter and more flexible. In addition to presenting the basics of multi-agent theory, this chapter covers some design procedures and provides several examples, as well as perspectives for future developments of MAS in power systems control. One of the most important parameters is to control the microgrid frequency & Voltage. The change represents a change in the rate of production and consumption And therefore a very important factor in the operation and control of the microgrid. The operation of a network, information on the frequency & Voltage of which shall be recorded the moment and this means that a large volume of information in a record time limit should be examined. It should be noted that the change in frequency & Voltage of more than nominal value in addition to causing damage to the facility's power grid, the means of electricity subscribers will also have detrimental effects Also, if the frequency & Voltage of the micro-grid and allowed optimal control and even collapse the network will not cause instability. Micro-grid frequency & Voltage response correction, especially in the event of an error,one of the decisive factors in the stability and performance of the system.

The implementation of a control network based on multi-agent systems where the user is able to decide intelligently convert a lot of research in this area.A multi-agent system is a combination of different factors cooperate to achieve the overall goal of a system. Agents must include a list of protocols that are well defined and represent different ways of communicating with nature (human or other agents) belonging to the system.Multi-agents systems (MAS), which have been applied in computer science studies for years, have characteristics that make them suitable for acting as a basis for building modern distributed control systems.In addition, artificial intelligence techniques can be embedded in some agents with smart features, particularly in automating tasks traditionally performed by human operators [1].

Frequency & Voltage control of an autonomous microgrid is achieved by coordinating the energy storage (ES),such as superconducting magnetic energy storage (SMES) and battery energy storage (BES), available distributed generators (DGs), such as wind turbines (WTs), photovoltaic (PVs), and micro turbines (MTs), and controllable loads. An autonomous microgrid is an isolated power system with a small equivalent inertia,which makes its frequency & Voltage control more difficult than conventional power systems. Because of the operation mode, transfer and intermittent characteristics of some distributed generators, frequency & Voltage deviation caused by active power deficiency or shortage often occurs in an islanded microgrid [2], [3]. As a result, the frequency & Voltage of the microgrid will fluctuate and may change rapidly due to the low inertia present and even experience a blackout unless there is adequate available spinning reserve to balance it [2], [3]. ESs can absorb or inject instantaneous power to provide support for primary frequency & Voltage control [4]. Subsequently, it was recognized that the power distribution of DGs can also play an important role in maintaining the frequency & Voltage stability and regulating the microgrid to a new balanced state [5], [6].

A two-layered hierarchical frequency & Voltage control scheme with microgrid central control (MGCC) was proposed to achieve cooperative frequency & Voltage recovery by coordinating the ESs and DGs [7], [8]. Similar to two-layered hierarchical frequency & Voltage control, the corresponding centralized multi-agent system (CMAS) also requires a powerful MGCC [9], [10], which is expensive and can easily suffer failures when handling huge amounts of data. An incremental cost consensus algorithm under different communication network topologies in a smart grid was studied and the convergence of the proposed algorithm was analyzed in [11]. An MAS-based scheme for a microgrid was presented in [12] to secure critical loads for a PVbased microgrid, and a centralized MAS-based frequency & Voltage control method was proposed and investigated in [9] to enhance the frequency & Voltage stability of an islanded microgrid. in [13] focused on micro-grid and propose a new multi-agent-based load shedding scheme and multi-agent architecture to realize the resilient power grid. Therefore, in this study, we present an algorithm for load shedding in which each agent in addition to voltage and frequency load & Voltage will be a priority for load shedding. Also this algorithm to assessing which must be removed before the fuzzy method is applied. We used fuzzy, it's fast response is selected, Faster system starting when you want to remove loads and the resulting loss of voltage and frequency & Voltage in system is greatly reduced. Load shedding method proposed in this study is ensure that loads essential in the island microgrid. An example is shown in Figure 1.

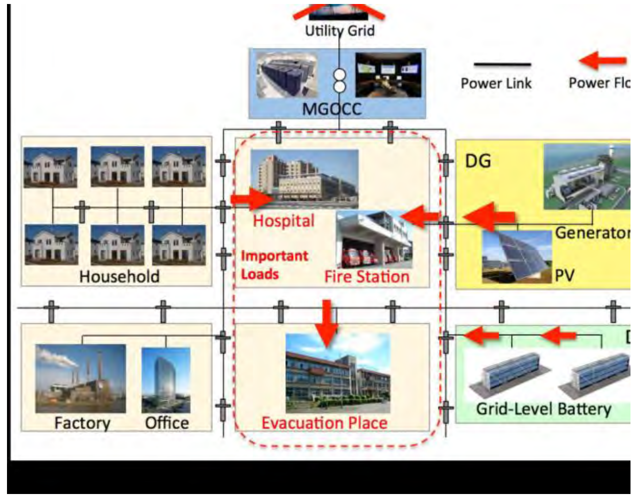

Fig. 1. Overview of Proposed Load Shedding Considering the Priority of Loads

II. RELATED WORK AND PROBLEM

An agent (or an intelligent agent) can perceive its environment and makes a decision against changes of the environment, and can act to resolve them autonomously according to its design purpose using its reactivity, pro-activeness, and social ability [14]. Since the characteristics of multiagent system are well suited for the operation of microgrid, it is well established that agent-based operation is efficient for microgrid operations well as for Smart Grid operation [15].There are researches which focus on microgrid operation by applying multiagent system [15] [16] [17]. In the existing research [15] [16] [17], the agents in the proposed system collect information of each component and send the information to decision making agent. The decision is sent back to the component agents. For example, one of the existing researches [17] proposed a system that adjusts the amount of thermal power generation, taking into account the amount of load demands. Also, since micro grid has distributed generator and usually some of them are using renewable energy, this research considers the transition of power generated by Wind turbine generators.This research [17] is trying to adjust the load demands, which are the given value in their simulation. Although managing demand from loads is challenging because there are several aspects to deal with. In the field of agent-based micro grid operation, there is also a research which focuses on the division of power in islanded micro grid [18], which is closely related to the focus of this paper. This research investigates a load-shedding scheme using the Talmud rule in islanded micro grid operation based on a multi agent system. The Talmud rule originating from the Talmud literature has been used in bankruptcy problems of finance, economics, and communications [19].They propose to use Talmud bankruptcy rule to divide power in micro grid. In the existing model of micro grid operation, since demand side and supply side operate independently, it is highly challenging to ensure the power for particular loads which are socially important in a disaster situation. It is a crucial problem for micro grid operation during a disaster situation, because it is highly challenging to ensure the power for the important loads. The socially important loads are, for example, hospitals, evacuation places and other places which are crucial to sustain people's life in the disaster situation. Another aspect of problems among the existing research is about the architecture of multi agent system [15] [16] [17]. In these existing research, there are agents which represent MGOCC, Load, DG, and DS.When MGOCC agent tries to gather information in the micro grid, all the agents representing Load, DG and DS send messages to MGOCC agent at the same time. This paper focuses on the autonomous islanded microgrid.

operation in a disaster situation, these points mentioned below are considered to be the issues in the exiting researches.

1-Ensuring the power for important loads is difficult in islanded microgrid using the existing operational Scheme.

2-Concentrated computational cost in MGOCC Agent.

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A. Solution

We propose solutions for the problems mentioned in the previous section. These solutions are summarized as follows: Using the agent-based hierarchical for microgrid and disposed of according to priority loads times.

B. Procedure

When power is not available for all loads, first MGCC be required to ensure the main loads. The sentence does not mean that be not provide other loads, it loads the main power supply to the loads will be left will no longer does. In this study, each of which has been given priority loads, that some of the loads have the same priority. The algorithm used is is shown in Figure 2, All loads their requests and changes immediately sent to the MGCC. also Distributed generation is doing the same thing.

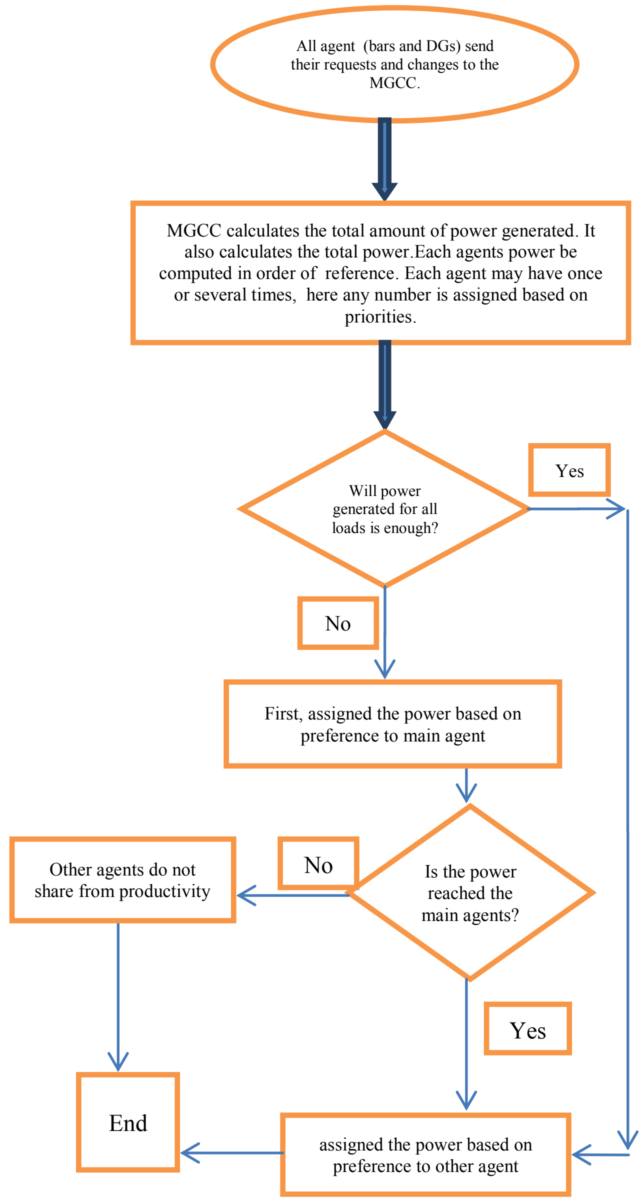


Figure. 2.The proposed algorithm for load shedding

III. MODEL AND STRUCTURE OF MICROGRID

In islanded microgrid, two control levels of MAS are distinguished as presented:

First Level: microgrid central frequency & Voltage controller (MGCC) agent. The MGCC is the main responsible for the frequency & Voltage control of the microgrid. It simply coordinates the local controllers, which assumes the main responsibility for frequency & Voltage stabilization. MGCC monitors frequency & Voltage, collects the information of generations and loads, sends commands to local agents, and communicates with upper distribution network controller when microgrid works in grid-connected mode.

Second Level: local controller (LC) agent. LC includes distributed generation agent (GA), energy storage agent (SA), and load agent (LA).MGCC control the GA, SA and LA to improve the frequency & Voltage stability of micro grid.

A sample of these levels are shown in Figure 3.

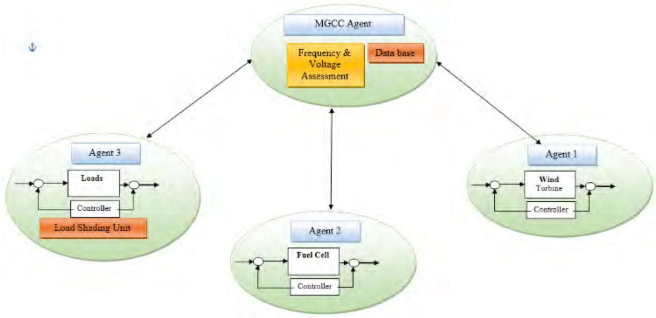


Figure. 3 Structure is provided with two types of distributed generation and loads

In the second level agents can only control their local parameters , but anyway ordered to change their performance from MGCC. The load agent is a part of load shedding in case of detected by MGCC acting load shedding its load shedding operations.

IV. EXPERIMENT AND EVALUATION

In order to evaluate the proposed load shedding scheme and hierarchical architecture, we have designed and developed a miniature microgrid for demonstration experiment. The main purpose of performing demonstration experiment is to evaluate the effectiveness of our load shedding scheme in physical difficulties, such as the gap between sensed value of power consumption and actual power consumption, overload of power by loads, etc.

The system is used for load shedding, including the following:

• producers agent (including wind turbine is 3)

• load agent (which is three loads: the load divided into 3 major and 3 normal.)

• Central agent: a moment of sampling the voltage and frequency & Voltage.

It is shown in Figure4,5,6

Each of loads take active and reactive power.These loads are isolated by isolation from the power grid. Normal loads is green and major loads is red. There is also ranked among the loads with the same priority.What a load on those higher priority.

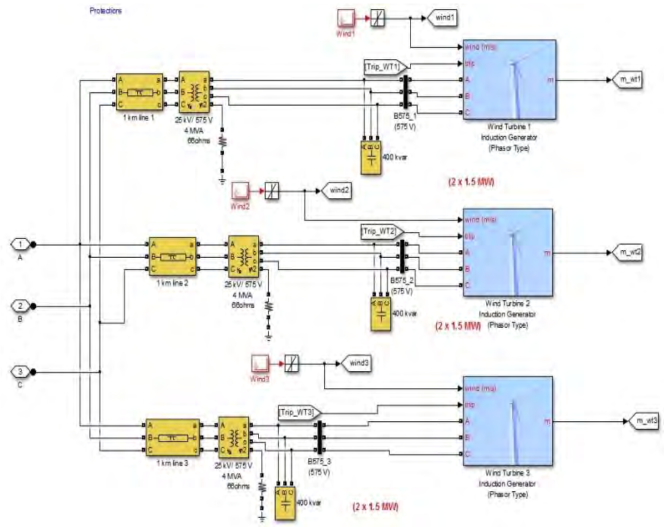


Figure. 4 The three wind turbine power generation is uniform.

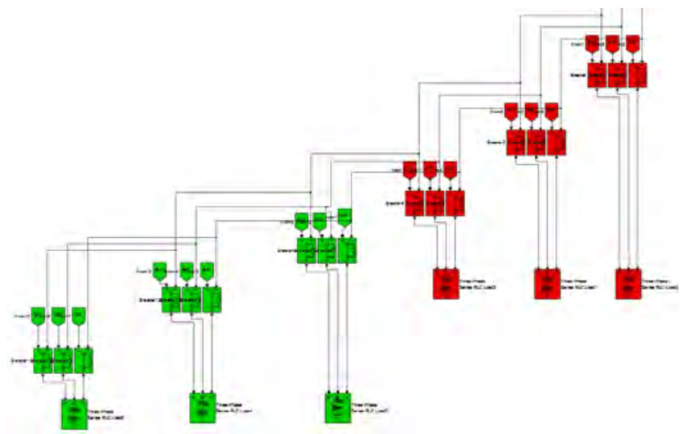


Figure. 5 Load agent, which is made up from 6 load. Normal loads is green and major loads is red.

Figure. 6 Agent centralized control from 3 parts of sampled and a decision is made to begin load shedding and load shedding control.

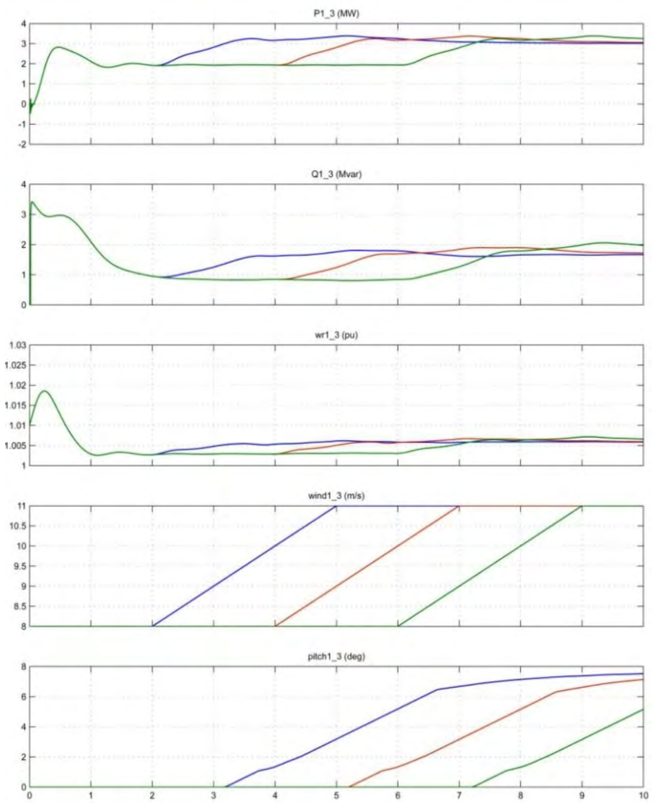
After the MGCC to allow load shedding. Loads that will be wiped out in the next section separated from other loads. This part of a fuzzy control algorithm is used for load shedding.

V. SIMULATION

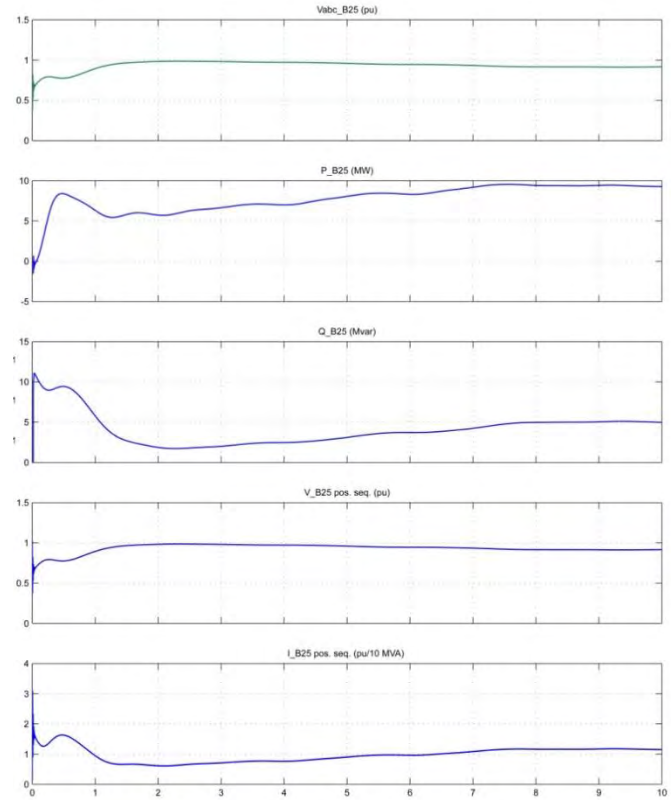
This paper is analyzed a system, using the simulation software Matlab 2013. Results are shown for different scenarios for each load.

A. Normal operation of the grid idle load

Figure 6 is waveform generation and load.As seen in the figure, because of the system no-load production voltage also higher 2Pu, but the B25 bus voltage remains on 1Pu and not have much changes and transient state has very few. The Power consumption has reached near 10Pu and reactive power 5Pu looks.



A) curves for part production

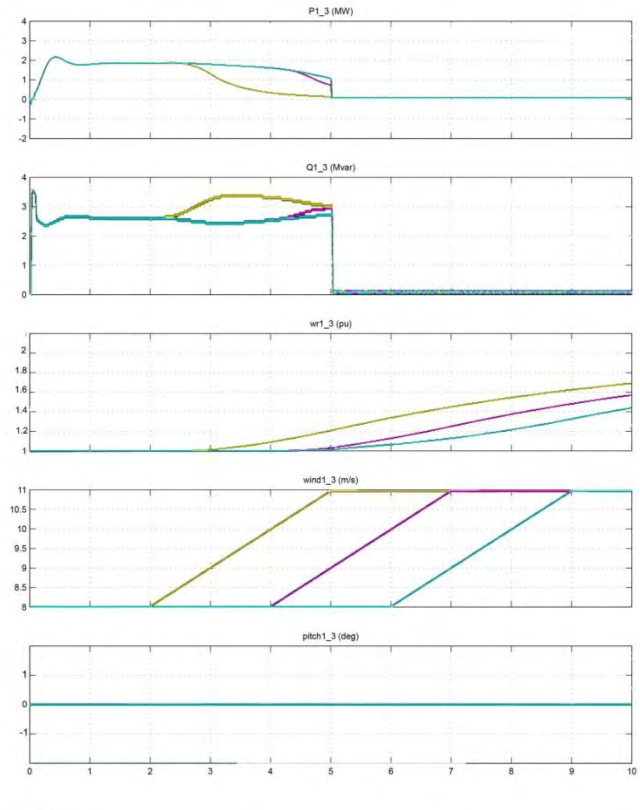


B) curves for part load

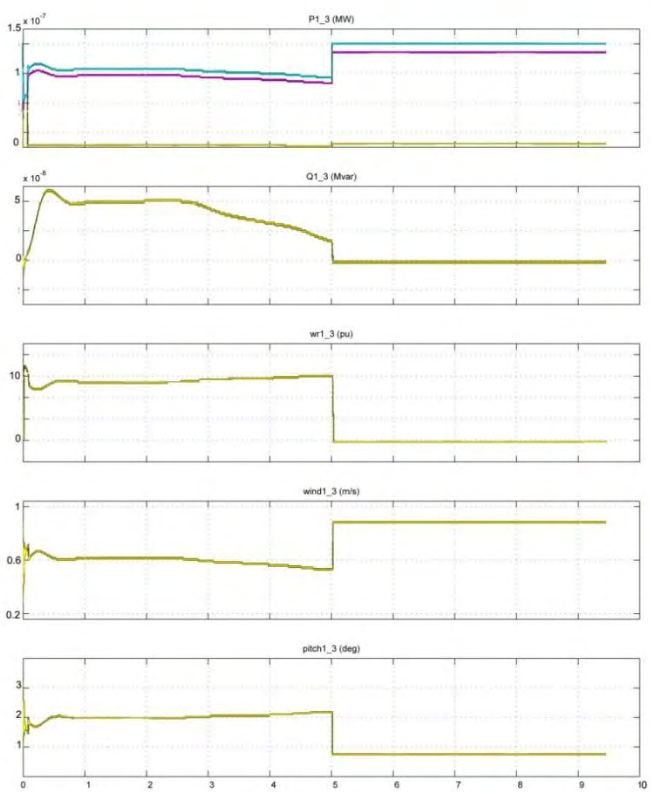
Figure. 6Curves of no load and normal operation of the grid:

B. placing system in full load

In this mode, all loads are applied to the system with the proviso that removal load shedding part, the results shown the Figure.7.



A) curves for part production

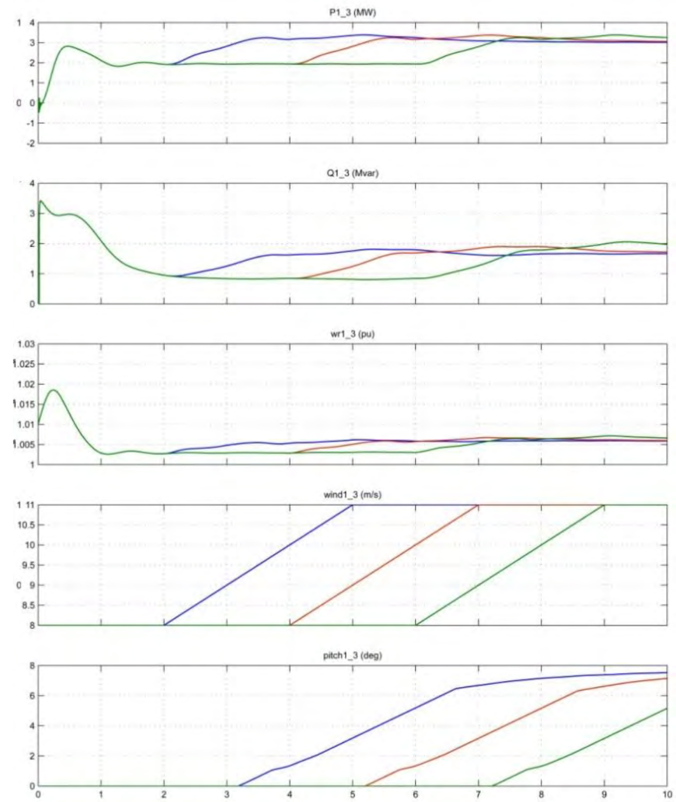


B) curves for part load

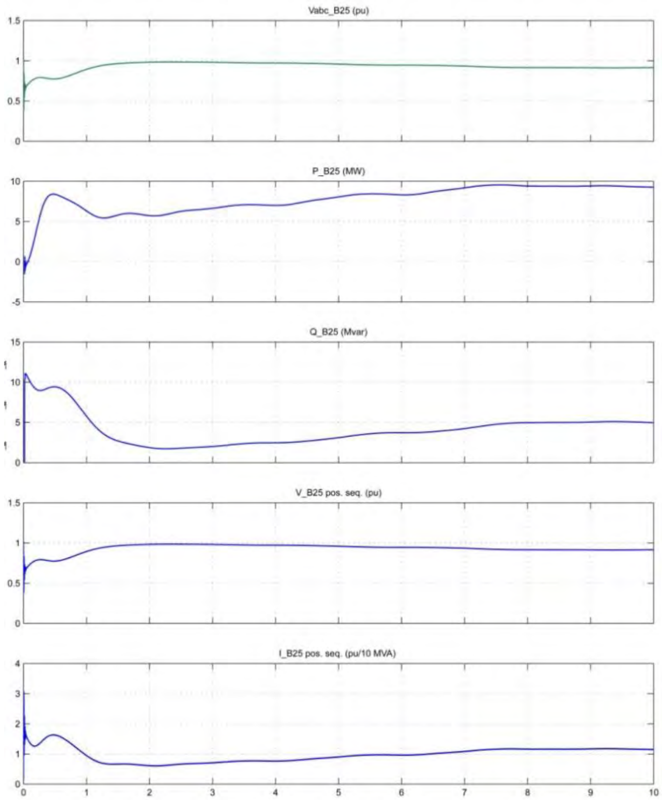
Figure.7Grid function curves at full load without load shedding part: A) curves for part production B) curves for part load

C. Enable the load shedding

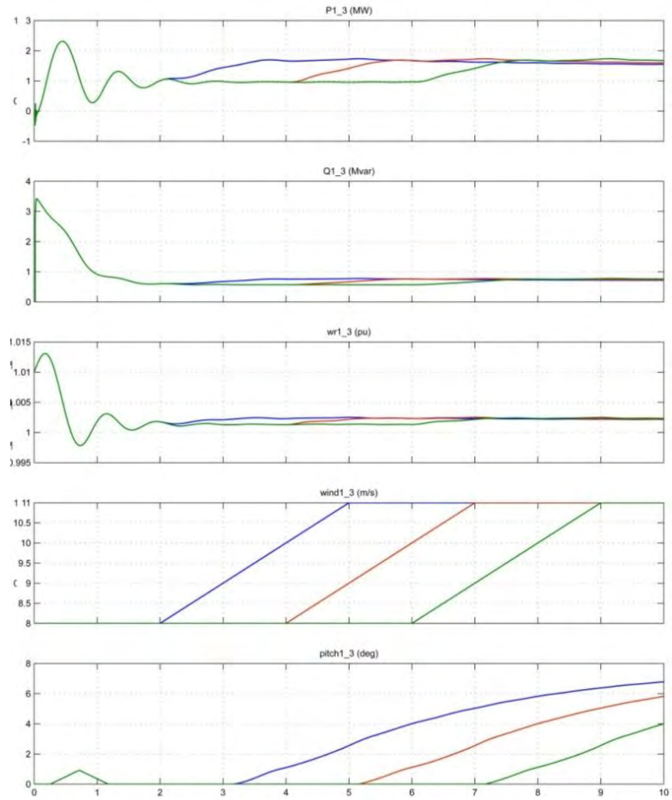
At this stage we enter part load shedding. Load shedding algorithm starts working and two times that normal load is considered out of orbit. The results shown the Figure 7. The MGCC ordered to isolator units, and load it is removed from the circuit. On this algorithm first starting to separate the loads normal, and then towards major loads and separated their network priority.



A) curves for part production



B) curves for part load



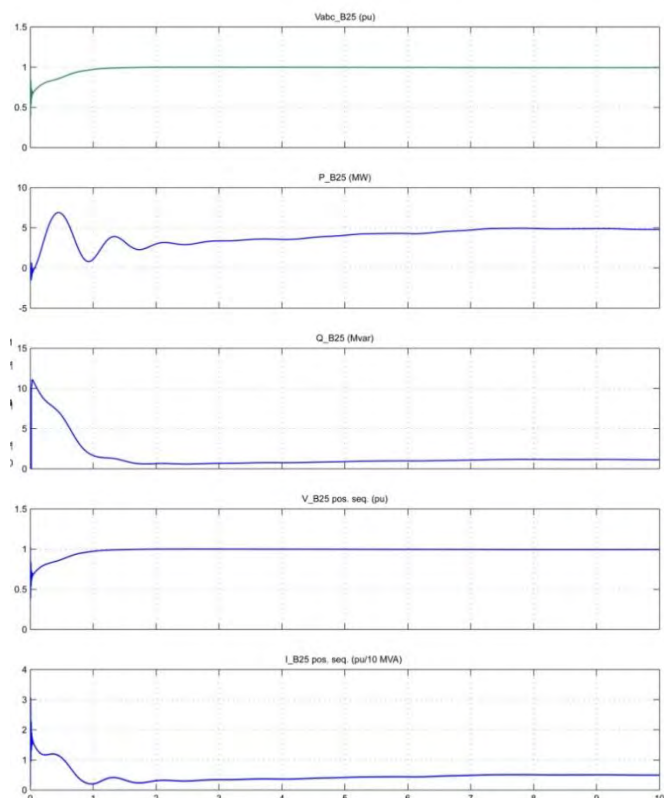
A) curves for part production

Figure. 8 The desired system curves, after applying the load shedding algorithm and out of two loads of grid part:
A) curves for part production B) curves for part load

Following adding the part control (load shedding algorithm) to desired system, Two load out of circuit, and finally system will reaches its optimal performance.

D. Reduce by half the production power and load shedding algorithm

On system desired for all normal loads are switched off and the system goes back to normalshows in Figure 9.



B) curves for part load
Figure.9 The Reduce the power production to the half and removed the normal loads part:

A) curves for part production B) curves for part load

VI. CONCLUSION

In this paper, application of MAS for the frequency & Voltage control of islanded Microgrid by Load shedding method is presented.As seen on the simulation, Load shedding algorithm is able correctly loads desired to remove from outside circuit and also differentiate for removed the normal loads and important loads. Thus, in the normal load, there is priorities that this prioritize the border is very important, and it is also considered for the study.

Simulation results show that the frequency & Voltage of islanded microgrid is controlled by the proposedmulti-agent system properly. Output of each distributed generation and energy device is dominatedby intelligent agents successfully.

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