

Control and Management of Distribution System Using MAS

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Abstract: In this paper, application of MAS for the frequency & Voltage control of islanded Micro grid by Load shedding method is presented. Frequency & Voltage stability of micro grids under islanded operation attracts particular attention recently. The islanded micro grid makes its frequency & Voltage control more difficult than the conventional grids. On This strategy, agents sent data and furthermore each component has its own to center operating decisions (MGCC). The simulation results show the promising performance of the proposed structure of the controller based on multi agent systems.

Keywords: *Control and Management, Distribution System.*

Introduction

The implementation of a control network based on multi agent systems where the user is able to decide intelligently converts 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. 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 micro grid 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 micro grid. 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. Typically, most energy management systems are based on centralized controllers. For instance, a generic centralized EMS utilized

for managing power converters in a micro grid that consists of wind and Photovoltaic (PV) systems as described in [1]. In [2], the centralized EMS was used to coordinate the micro-generators with the main grid for minimizing the greenhouse gases (GHG) emissions, energy costs, and maximizing the power output of renewable energy systems. Furthermore, in [3], a micro grid central controller was used to optimize supply and demand profiles for mitigating fuel consumption costs. Conventional EMS architecture is summarized in Fig. 1. The central supervisory controller is used to optimize the usage of fossil fuel based distributed energy resources (DERs), renewable DERs, and energy storage in the micro grid. It commonly consists of a communication network that monitors the DERs and also sends commands to local controllers in order for the dispatchable resources to deliver power to the load in the most promising economical method. Despite its universal successes, this system's top down approach has several drawbacks. It represents a 'single point of failure', which means that it has to be securely planned with proper redundancy built in [1,4].

In addition, the complexity of the centralized energy management system grows exponentially with the growing number of generators and loads causing the higher cost of communication for scheduling and online monitoring [5, 6]. Moreover, the centralized controller needs to be updated and reconfigured for any changes in the micro grid structure or when new generators or loads are installed [6]. Although centralized control methods may be used to find the best control solutions, it requires powerful computing ability in order to deal with a huge amount of data as the systems become bigger and more complex [6]. It also needs a

network with a highly distributed control strategy and communication capabilities [7]. A two-layered hierarchical frequency & Voltage control scheme with micro grid 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 micro grid was presented in [12] to secure critical loads for a PV based micro grid, and a centralized MAS-based frequency & Voltage control method was proposed and investigated in [9] to enhance the frequency & Voltage stability of an islanded micro grid 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. 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 micro 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. An example is shown in Figure 1.

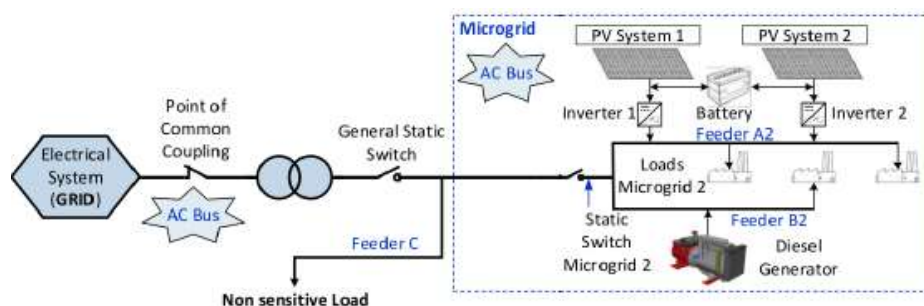


Fig. 1: Overview of proposed load shedding considering the priority of loads

Statement of the Problem

Since the characteristics of multi agent system are well suited for the operation of micro grid, it is well established that agent-based operation is efficient for micro grid operations well as for Smart Grid operation [15]. 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, proactiveness, and social ability [14].

There are researches which focus on micro grid operation by applying multi agent 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.

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 this existing research, there are agents who 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 micro grid.

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

- Ensuring the power for important loads is difficult in islanded micro grid using the existing operational Scheme.
- Concentrated computational cost in MGOCC Agent.

Multi-agent Systems Concept

Multi-agent Systems

MAS is one of the domains in agent based technology that deals with modeling of independent or autonomous decision-making units [17]. It is comprised of a group of agents that are able to interact with each other [22]. The MAS method is rarely used in the electrical engineering field. Undeniably, the use of MASs offers difficulties in the electrical engineering area which includes the broad collection of design practices, variety of agent structures, and various methods of implementation [23,24]. MAS EMS for a micro grid is among the preferred options for implementation of an intelligent power system, where each essential component is represented by an intelligent autonomous agent. Therefore, in this paper, the micro grid system's power generations, consumer loads and all other components in the network are monitored and controlled by an autonomous agent with a common communication bus.

Agents

There is no universally agreed-upon definition on what an agent is [18,25]. However, an agent generally means a computer system that is placed in an environment that is to achieve its design objectives [25].

An agent also can be viewed as a system that is able to perceive its environment through sensors and act upon that environment by means of actuators [22,26]. So, an agent is typically represented by any control system. However, an intelligent

agent is defined as an agent capable of doing flexible autonomous action in order to achieve its design objectives [25]. It has three key features namely reactive, proactive and social abilities [23,25, 27]. Reactivity is the ability of the agent to perceive the environment and react to any changes.

Pro-activeness is the intelligent agent's ability to display goal-directed performance. Lastly, the intelligent agent's social ability is

its capability to interact with other agents either in a cooperative or competitive manner. All the agent's characteristics tend toward achieving its design objectives by taking into consideration its available resources and skills, and also rely on its perception, communications, and representations.

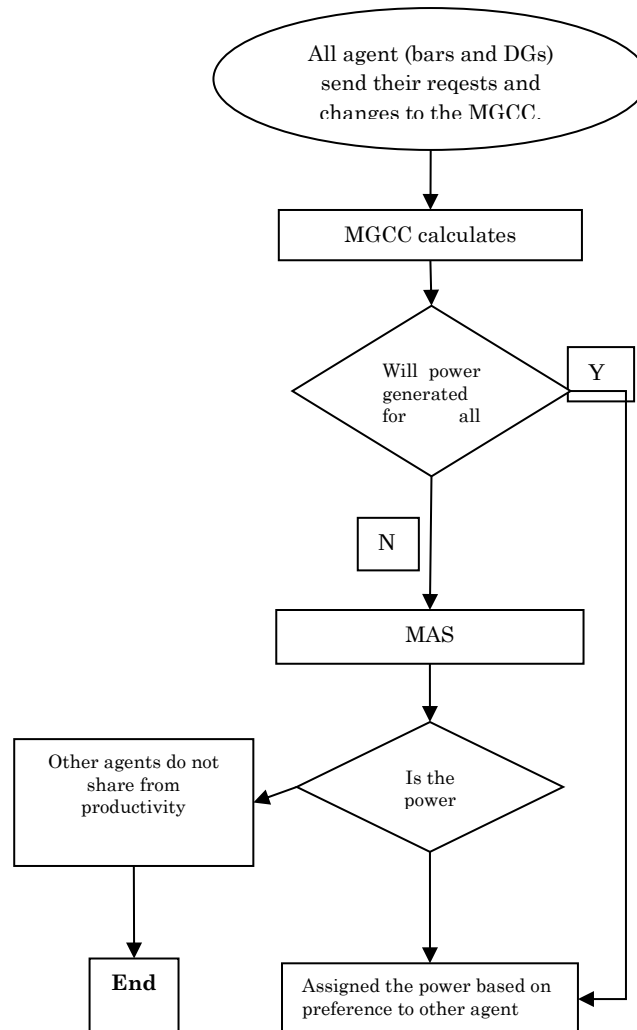


Figure 2: The proposed algorithm for load shedding

MAS for Energy Management

This paper focuses on the use of an MAS in order to optimize the hybrid renewable energy system's performance. The hybrid renewable energy system is comprised of PV systems, wind turbines, battery storage

systems, micro-hydropower systems, and diesel generators.

The proposed MAS based EMS will be able to provide the following solutions to the micro grid system:

- Coordination mechanism and communication protocol for all elements in the micro grid,
- Control schemes based on the output characteristics of various types of power sources,
- Control strategy to optimize the trade-off between the system's performance and operation cost,
- Optimization of the micro grid system's operation considering load demand and intermittency of RE resources, and
- Optimal usage of each component in the micro grid.

Evaluation

In order to evaluate the proposed load shedding scheme and hierarchical

architecture, we have designed and developed a miniature micro grid 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 Load agent
- Central agent: a moment of sampling the voltage and frequency & Voltage.

It is shown in Figure 4, 5.

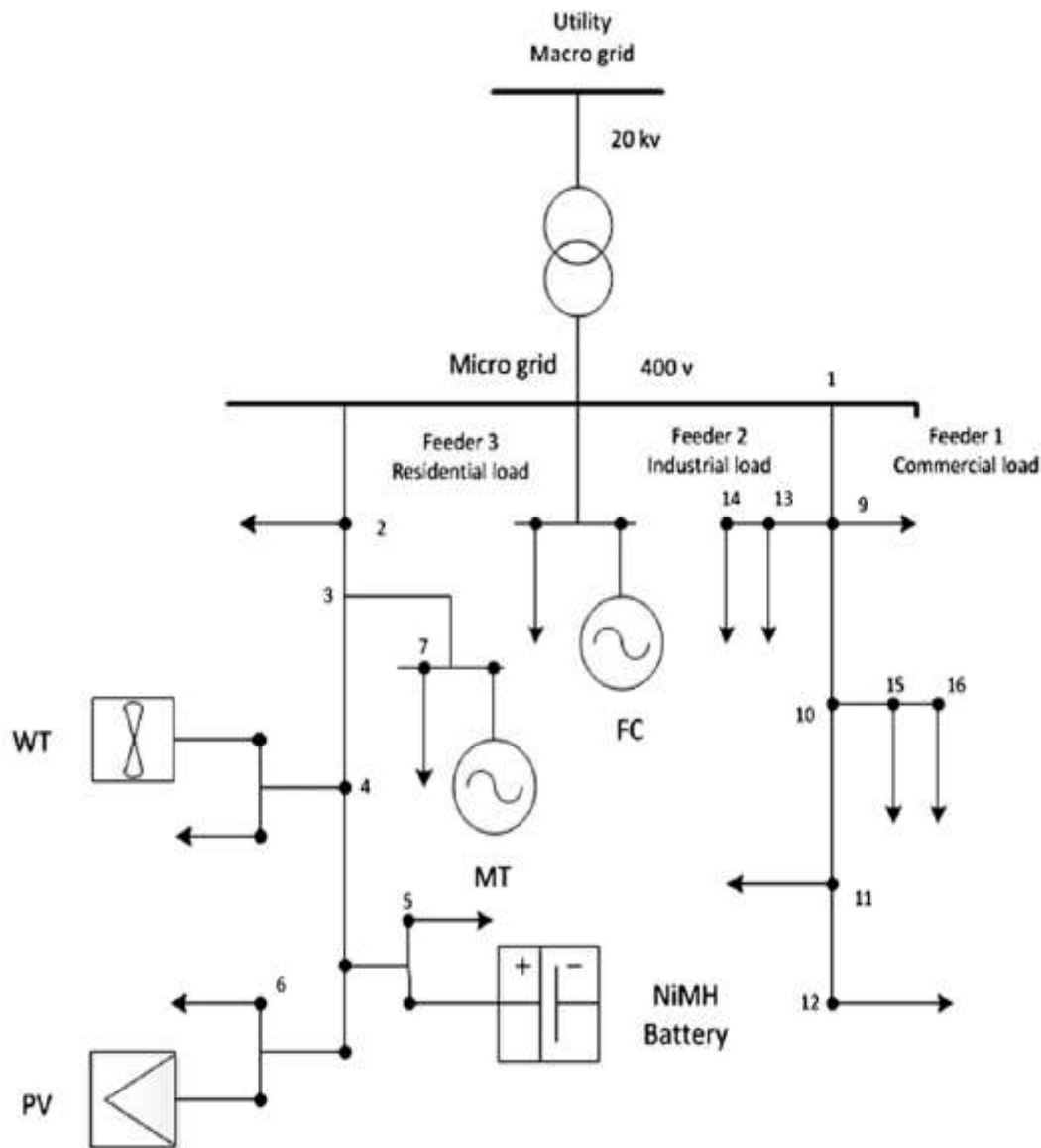


Figure 4: The sample microgrid

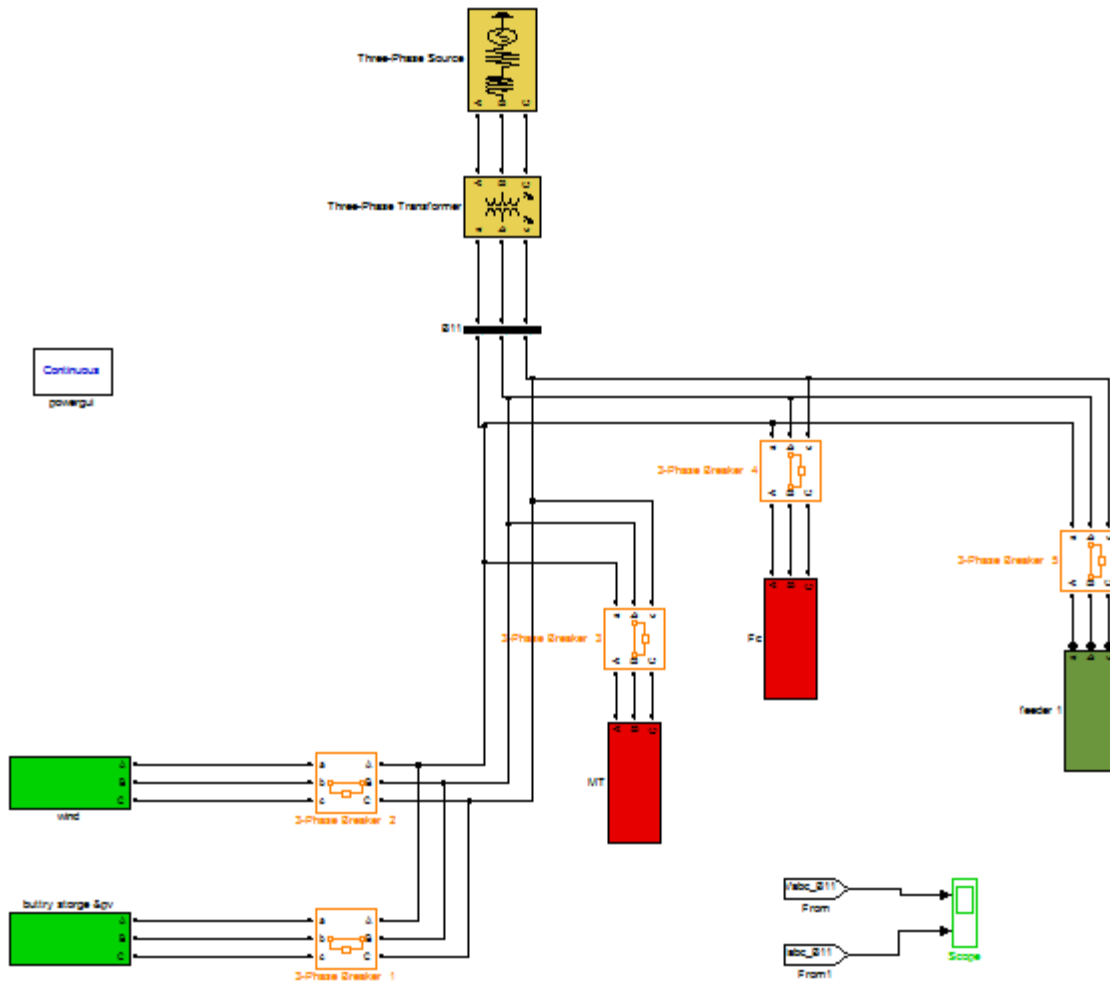


Figure 5: Simulation of system

Simulation

This paper is analyzed a system, using the simulation software Matlab 2012. Results are shown in figure 6 and 7 for different scenarios for each load.

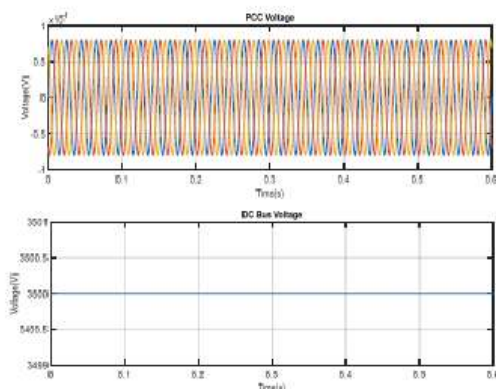
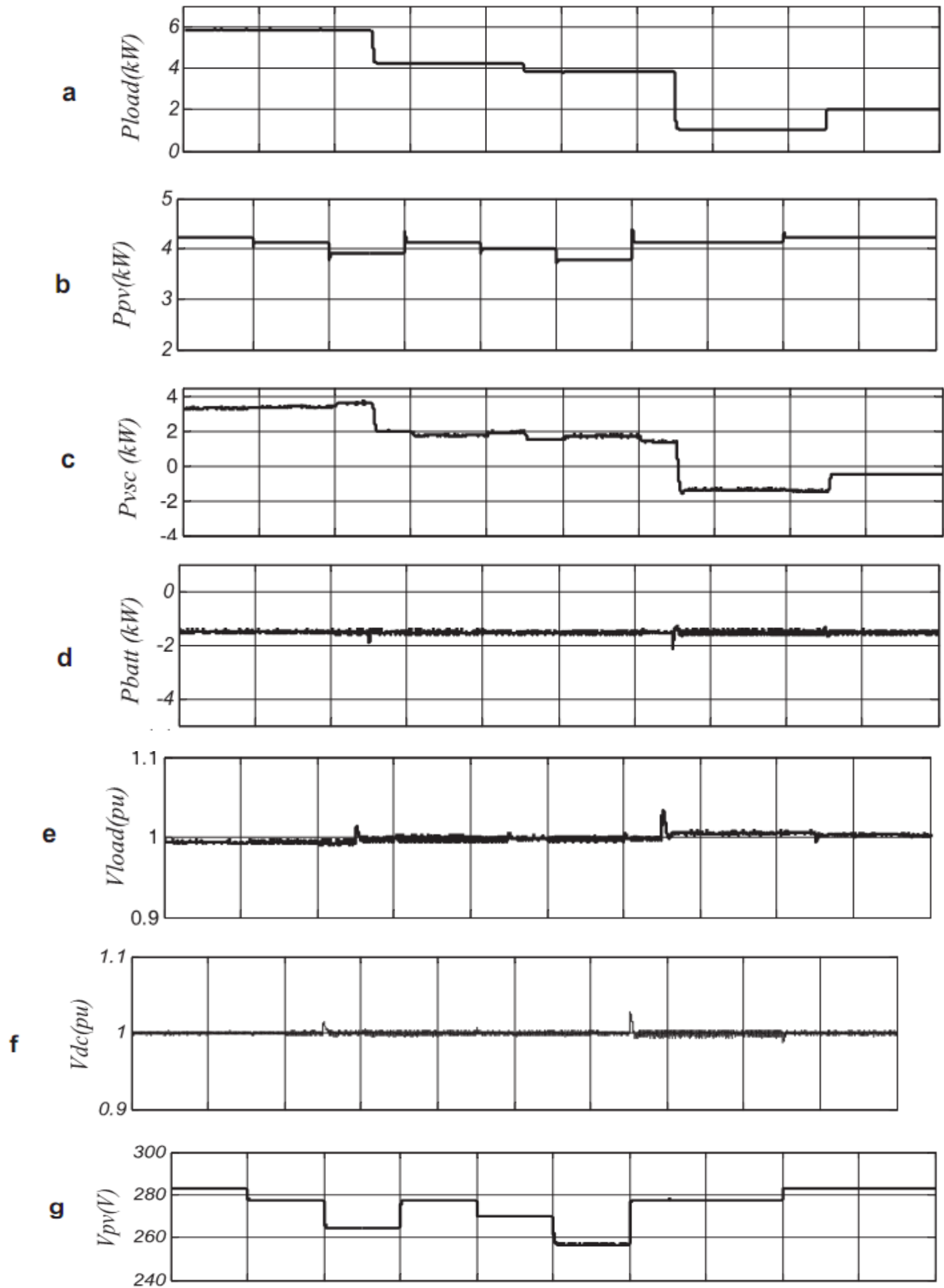


Figure 6: Change in AC microgrid load. PCC point Voltage; and DC bus voltage.

Conclusion

In this paper, application of MAS for the frequency & Voltage control of islanded Micro grid 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 micro grid is controlled by the proposed multi-agent system properly. Output of each distributed generation and energy device is dominated by intelligent agents successfully.



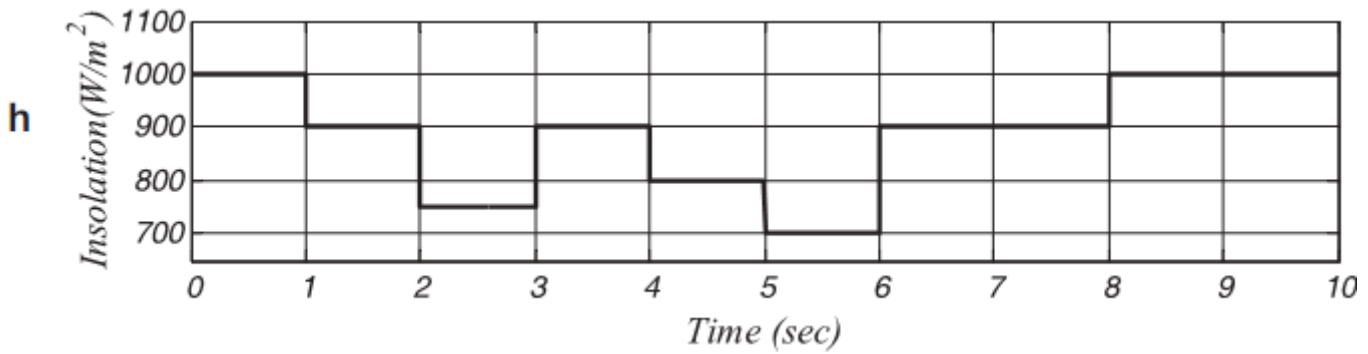


Figure 7: System operation during load and PV generation variation in grid connected mode, (a) Total load (kW), (b) PV power generation (kW), (c) Power import/export by the GS-VSC (kW), (d) Battery charging power (kW), (e) DC voltage at load point, (f) DC-link voltage at GS-VSC (pu), (g) Solar insolation variation (W/m²), (h) PV array voltage (Volts).

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