Abstract

The development of new technologies in power industry like renewable energy resources and other new creations in power electronics for the improvement of power quality has forced the power industry to shift for distributed generators. A solution to solve the power crisis problem can be given with the help of load shedder module which is done in an intelligent way. Thus the intelligent load shedder module has been created thereby the load management. Here the solar energy is considered as the distributed generator. The load management can be carried out with the help of load shedding. The proposed load management method within this paper are simulated by using the MATLAB Simulink and then verified by hardware set up.

1. Introduction

This paper presents the load management for the grid connected photovoltaic system. Thus the load management can be carried out by using the load shedder module. Load management is needed in every power system. Demand has been increased due to the lack of generation so in order to meet
the demand and satisfy the need of the consumer load management is necessary. Load management, also known as demand side management (DSM), is the process of balancing the supply of electricity on the network with the electrical load by adjusting or controlling the load rather than the power station output. A micro grid is a localized grouping of electricity generation, energy storage, and a load that normally operates connected to a traditional centralized grid. This single point of common coupling with the main grid can be disconnected. The micro grid can then function autonomously. Micro grid generation resources can include fuel cells, wind, solar, or other energy sources Micro grid can supply power to small/medium sized urban housing communities or to large rural areas (3). The multiple dispersed generation sources and ability to isolate the micro grid from a larger network would provide highly reliable electric power. Produced heat from generation sources such as micro turbines could be used for local process heating or space heating, allowing flexible trade-off between the needs for heat and electric power(5). The micro grid encompasses a portion of an electric power distribution system that is located downstream of the distribution substation, and it includes a variety of distributed energy resources (DER) units and different types of end users of electricity and/or heat. DER units include both distributed generator (DG) and distributed storage (DS) units with different capacities and characteristics (5).

DER units, in terms of their interface with a micro grid, are divided into two groups:
1. The first group includes conventional or rotary units that are interfaced to the micro grid through rotating machines.
2. The second group consists of electronically coupled units that utilize power electronic converters to provide the coupling media with the host system.

The control concepts, strategies, and characteristics of power electronic converters, as the interface media for most types of DG and DS units, are significantly different than those of the conventional rotating machines. Therefore, the control strategies and dynamic behavior of a micro grid, particularly in an autonomous mode of operation, can be noticeably different than that of a conventional power system.

## 2. Load Shedding

In general, load shedding can be defined as the amount of load that must almost be instantly removed from a power system to keep the remaining portion of the system operational (4). This load reduction is in response to a system disturbance (consequent possible additional disturbances) that results in a generation-deficiency condition. Common disturbances that can cause this condition to occur include faults, loss of generation, system islanding, switching errors, and lightning strikes. Intelligent load shedding can be done and the needs for intelligent load shedding (ILS) are as follows. Because of the inherent drawbacks of existing load shedding schemes, an ILS system is necessary to improve response time, accurately predict the system frequency decay, and make a fast, optimum, and reliable load-shedding decision.

### 2.1. Proposed Techniques Of Load Management

#### 2.1.1 System Description of Load Management in the Micro Grid

In this paper load management can be carried out by using the load shedding concept in grid condition. It can be carried out by using the algorithm that is based on the real, reactive power and frequency values. Here load shedding has been done for the disturbances that are produced in the grid. When a generator is connected to the distribution system of load there will be some variations occur in the system for that kind of disturbances the load shedding is carried out in this paper. Load
shedding is that can be defined as the amount of load that must almost be instantly removed from a power system to keep the remaining portion of the system operational. This load reduction is in response to a system disturbance (consequent possible additional disturbances) that results in a generation-deficiency condition.

![Figure 1: Block diagram of a load management for the grid connected photovoltaic system](image)

Load shedding is a measure of last resort to prevent the collapse of the power system country-wide (1). When there is insufficient power station capacity to supply the demand (load) from all the customers, the electricity system becomes unbalanced, which can cause it to trip out country-wide (a blackout), and which could take days to restore. Load shedding is aimed at removing load from the power system when there is an imbalance between the electricity available and the demand for electricity. If we did not shed load, then the whole national power system would switch off and no one would have electricity. Load shedding is therefore done to protect the national power system from collapsing.

### 3. Simulation and Results of Load Management

![Figure 2: Simulink diagram of distributed generator for load management](image)
Fig. 2 shows the distributed generator in micro grid. The islanding condition of distributed generator is depicted in this Simulink diagram. Here in this paper the islanding protection of distributed generator is carried out with the help of the control algorithm. Thus the algorithm was performed with the help of logic gates and relational operators. The wind energy is considered as the source for the distributed generator and the capacity of each distributed generator is considered as the 15 KW. In this paper there are four distributed generators in micro grid. Hence the total capacity of micro grid is 60 KW. At first the voltage and current is measured and then by using the power block (dq0 instantaneous) the real and reactive power values are measured. Then by using the PLL block the frequency values are measured. The minimum and maximum limits of frequency is set as the standard value such as minimum value as 49.5 Hz and the maximum value as 50.5 Hz is set. Then the RMS (root mean square) block is used for the leveling the ripples in the values of power. Gain block is used for the purpose that if there is any change in the input side then accordingly it will generate the signal. The reference real power value is 1.75 p.u and it is then compared with the relational operator and the output of the relational operator is given to the input to another logical operator which is an AND gate then another input for the AND gate is reactive power value. There the AND operation is performed in which the reference value of the 0.23 p.u is compared with the reactive power value with the RMS (root mean square) block with the help of the relational operator. After that the other constrain of frequency value is checked it has been done with the help of the relational operator and the reference value for frequency is 50 Hz. The one input to the relational operator is the RMS (root mean square) value of the frequency from the distributed generator. The other input to the operator is the reference value of frequency which is set at the 50 Hz. The output of the operator is given to the OR logic gate for the purpose of checking the error occurred in the system. After that it is given to the gain block and then to the NOT gate for reversing the operation. The output of NOT gate is given to the circuit breaker and if there is any kind of error in the system then the circuit breaker becomes trip condition and thereby the distributed generator becomes islanded. The error condition can be found out by knowing the deviations in the values of real, reactive power and the frequency values. It can be simulated by using the MATLAB software Simulink 2013 version. This process is carried out for the four distributed generators and the islanding condition for each DG’s are varied.

The shedding of DG’s are performed in the Simulink MATLAB. Here in this paper the load shedding can be explained as follows. Load shedding can be defined as the disconnecting the load from the supply for any kind of disturbance that occur in the power system. Load shedding is that can be defined as the amount of load that must almost be instantly removed from a power system to keep the remaining portion of the system operational. This load reduction is in response to a system disturbance (and consequent possible additional disturbances) that results in a generation-deficiency condition. In this paper the shedding operation is carried out for the disturbance that occurs when the load in the distribution system is connected to the distributed generator. For those disturbances shedding has been done with the help of the control algorithm (2). Here the control algorithm can be made with the help of the subtraction operator and the relational operator. The real and reactive power values are taken from the DG’s and then the gain block is used before the comparison of the values in order to get the change in value for any change that is present in the input side of the DG’s and after that the real power is compared by using the subtraction operator. Likewise the reactive power value is also compared and then the output value of the real and reactive power comparison is taken as the one of the input value for the comparison of
frequency by using the relational operator. Then the output of the relational operator is given to the call for function as the simulation block. In 1.while tripping the load the time delay will occur therefore in order to reduce the time delay the call function is used. After that the circuit breaker will get the signal and according to that signal the shedding has been done.

Here load is taken as the RLC load which is individually connected for each DG’s and their load shedding is carried out by using the constraints such as real, reactive power values and the frequency values are taken into account. Here shedding is considered for the purpose of protecting the system from any kind of large damages such as blackouts and equipment damages.

4. Result and Analysis of Load Management

![Figure 3: simulation result of load shedding for the load management](image)

The fig.3 shows the simulation result of load shedding. Due to the disturbance that is produced when the generation system is connected to the distribution system the load shedding is carried out in the Simulink model in MATLAB for the protection purpose. The shedding is carried out by using the circuit breaker to trip the load from the system for protecting it from any damage. The shedding period of DG 1 is from 1.5 sec to 3.3 sec as shown in the fig.3 during that particular time period the load is disconnected from the supply in order to meet the demand the load shedding is done by taking the constraints as the real, reactive power values and frequency values.

5. Conclusion

This paper describes about the load management. It is necessary since the demand has been raised. The generation and demand is not matched for the past few years. In order to supply the generating power to each and every consumers at least for a particular time period. The load management is needed and also in order to protect the power system from any kind of larger faults like blackouts. India was affected by black out in 2012 due to the frequency mismatch that occurs in the northern
grid and thus the entire part of the grid got collapsed except southern grid. For avoiding that kind of situation, it is necessary to shed the load for a while in order to match the generation with demand.

The objective of this paper is that the load shedding in which the shedding of loads are necessary in order to avoid the faults in the power system. Here in this paper the load shedding is carried out by taking the real, reactive powers and frequency values into account. The reference values have been set for these constraints and if there occurs any deviation in these values than the load shedding is made. After load shedding has been done, and then the synchronization is made.

References