

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 10, October 2017

Load Sharing Techniques in Power System

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ABSTRACT: There are different conventional load shedding approaches, such as under frequency control, but these have a slower response and are unreliable in correctly sharing load in the event of any disruptions or faults. This leads to a rise or decrease in loads, leading to a failure to satisfy the demand for electricity. The paper, which is called intelligent load shedding, addressed a modern form of load shedding. A proper comparative analysis between the traditional and intelligent load shedding approaches was addressed in detail from the perspective of architecture, engineering, implementation and operation. It has shown that all the demerits are overcome by the intelligent process of load shedding of conventional methods and is highly efficient, require very low cost of maintenance.

KEYWORDS: Power System Monitoring, Power System Simulation, Traditional Load Shedding, Intelligent Load Shedding, Frequency Relay, Programmable Logic Controller.

I. INTRODUCTION

The system in which electrical power demand is spread over a variety of power sources is coined as load shedding. When the energy demand is greater than what the power source can provide, load shedding is used to reduce the strain on the power source to the greatest extent possible. A customer purchases electricity from a service supplier. In order for the expenditure to be negligible, two conditions with the lowest cost of electricity and also an uninterrupted supply of power should be met. The customer or operator will then agree with the supplier on a fixed timetable or on-demand basis to shed a minimum portion of the load on a voluntary basis [1]. The user side would get power from other secondary sources, not from the main supplier, to make the load shedding phase feasible. On-site generators based on diesel, contracted or on-site photo-voltaic or some other renewable source of power are examples of such secondary sources. In blackouts, whether the suppliers fully stop or reduce the energy supply for a shorter time, the consumers experience automatic load shedding. In brownouts, if the supplier decreases the voltage delivery during peak hours so that there is a balance between demand and supply, consumers experience automatic load shedding. In brownouts, the customers experience an automatic load shedding if the provider lowers the distribution of voltage during peak hours so that there is a balance between demand and supply. Thus in order to maintain proper operation of the necessary components, the part of load that can be taken out instantaneously is termed as load shedding. The reduction in load is caused by any disturbance such as fault, generation loss, errors in switching, lightning strikes that result in reduction of generation. There are two methods for controlling the transient and dynamic responses of a system whenever exposed to any kind of disturbance[2]. The first one is an excitation loop in which the reactive power and voltage level of the system is controlled and varied.

Second one is a prime mover loop where the active power of the generator and frequency of the system is controlled and varied. Both these techniques are discussed below[3].

Excitation loop: There will be a dip in the reactive power if a fault occurs in the device. For the conversion of electrical energy into mechanical energy, reactive power is used and vice versa in the electro-mechanical domain. The flux energy of the system is then decreased due to fault as soon as the fault is cleared. As soon as the fault is cleared, there is pressure on the rotating machine for proper balance between the generation and demand as well as maintain the level of magnetic energy. The demand for operating voltage and voltage regulation is a function of the reactive power that is

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deliverable by the system. If there are high disturbances, then generators make use of its capability of over-excitation for the stability of the system to get back to normal conditions[4].

Prime-Mover: In case of any malfunction, prime mover styles and turbine governor will also affect the performance of the machine. The generator is given mechanical energy to move through any fault or disruption and this energy is different for different types of turbines, such as gas, turbo or hydro. In the transient and steady state of the system, this change in energy can produce a disturbance. Lightning strikes or switching strikes in the networks can also lead to more disruptions[5]¹.

In the following pages, a variety of techniques have been addressed for the load shedding process. A scheme of breaker interlock is one of the techniques. A breaker is inter-locked by remote signals or hardwired to a group of load-breakers that have already been selected to fly. Signals are sent to the breakers to open if, for some reason, a generator breaker or grid link is lost. The decision on the amount of load to be shredded has already been made, so this device operates with no processing needed within a minimum period of time[6].

In the form of a line diagram, the technique for load shedding via breaker interlock is given. Anytime whenever as soon as the main circuit breaker opens, a signal will be sent to the interlocked load breakers without any delay in time. Since no study is done before doing the selection of the interlocked breaker, its opening and tripping will not be a function of transient response of the system leading to unwanted and extra shedding of loads. Following are some demerits of this technique of shedding of load:

1. The amount of load that needs to be shredded is calculated with respect to the scenario of worst case, also it is hard-wired. Thus it is not easy to change the priority of the load.
2. Availability of single stage load shedding only.
3. Many times over shedding of loads takes place.

The other method which is employed for load shedding is scheme of under frequency relay. Instead of detecting any disturbances, these relays any change in the frequency or any reduction in frequency. After the first stage, there is a wait of a predetermined time for avoidance of any nuisance tripping to give time to frequency to recover. If still there is a decay in the frequency, there will be an additional delay in time and time will be given to recover.

The load shedding technique of under frequency relay is shown in which there are a number of stages are given for connecting to the various circuit breakers stage wise until the frequency is back to the standard frequency of operation. This technique has several de-merits such as a few frequency relays having slower response time, extra or under load shedding leading to further disturbances[7].

The architecture for shedding of load is given in the form of a flow chart. A pre-calculation is carried out about the amount of load that needs to be shed and time for its shedding. The selection of the load that needs to be shed is on the priority basis. Shedding of loads is a function of setting of voltage of thresholds and under frequency and establishment of a loads on the basis of their priority to be done by a number of studies viz dynamic or static stability. In this study proposed load groups of most and least loads are chosen from the list of load shedding. In case there is a drop in frequency of rate of change of frequency, then the load group which is least critical is shed. If there is continuation in the drop of frequency, the next group in the priority ranking will shed. The process of shedding loads on the basis of priority will continue until the defined value of stability is met [5].

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II. LITERATURE REVIEW

Authors Farrokh Shokooh, J J Dai, Shervin Shokooh, Jacques Tastet, Hugo Castro, Tanuj Khandelwal and Gary Donner have proposed a state of art system for load shedding which makes use real-time data and that is updated in the model of the system. An optimum solution has been produced by the system for shedding of the required amount and thus termed as intelligent load sharing [2]. Authors Pierre C6te, Simon-Pierre C&e and Marc Lacroix have discussed the programmable load shedding system(PLSS) which is the key element in the protection system of Hydro-Qu6bec and carries out monitoring and controlling tasks. Their function includes monitoring of the frequency and voltage levels and carrying out any shedding in case of disturbances caused in either of these. But the cost and procedure of these have turned into complicated tasks if the spare parts are unavailable [3]. Authors Dennis Michaelson, Hisham Mahmood and Jin Jiang have proposed a management system for energy management with a micro grid that supplies energy with the help of photovoltaic cells and battery storage. The approach was validated by experiments and simulations that have shown the potential and feasibility for the scenario [4]. Authors Ali Parizad, Hamid Khoshkhoo, Shahab Dehghan and Rasoul Moradtalab have discussed a power network that has been isolated and is highly vulnerable in terms of its stability. An intelligent technique of load shedding has been discussed that is based on a smart load management system for proper operation in islanded mode. In the form of a block diagram, the intelligent load sharing scheme is explained. The system's knowledge base is educated by input and output databases from an offline system consisting of simulation and studies. The outputs of the knowledge base are complex system responses such as frequency variation. All of the system's operating conditions are constantly tracked by an automated monitoring system that operates a professional knowledge base system in the background.

III. CONCLUSION

In industrial power systems, the one guard for the safety of a system triggered by an overload after impact is load shedding. By using breaker interlocks, relays based on under-frequency and various other PLC-based systems, the mechanism is preserved from this collapse. But these are conventional load sharing strategies and hence have their share of limitations and demerits. A few of these are real time configuration, pre-fault and post-fault data unavailability. Thus, an intelligent approach called intelligent load shedding that combines system online data, system dependency, online and offline simulation information and a comparative analysis was proposed. This system has the capability of performing the process of load shedding in a time lesser than a hundred of milliseconds from the time of occurrence of any disturbance. A working model of intelligent load shedding system was mounted in PT Newmont in Indonesia. The power system gets its power from 4 thirty-four megawatt turbines of steams that were driven by generators and 9 five megawatt engines of diesel generators. The plant of generation of eleven kilovolts gives power through two transmission lines of 150 kV. The frequency of operation of the entire system is 50Hz and before sending out the voltage it is stepped down to 33kV. The system makes use of the technique given in table 2 of multistage frequency. In table 3, a comparison between intelligent load sharing and under frequency control is given.

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