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Load Frequency Control in a Deregulated Power System Using IPP Design

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Abstract- This paper deals with a load frequency control in a deregulated power system, in which the independent generator utilities may or may not participate. A suitable method has been developed for analyzing the performance of such a system. The load frequency control is performed by this method on the basis of parameters set by the participating genera tor companies. The method is based on an Independent System Operator (ISO). The participated companies are generators utility and Independent Power Producer (IPP). The generator utilities define which units will be under load frequency control , while the independent power producer may or may not participate in the load frequency control. The generator utility defines the generation limits, rate of change and economic participation. The ISO gets this information. The ISO also controls the interconnected system operation while at the same time allows the utilities to economically dispatch system.

Keywords: Area control error (ACE), load frequency control(LFC), deregulated system.

Introduction

The world – wide many electric utilities and power companies have been forced to change their way of operation and business, from vertically integrated utilities to open market systems. For developing countries the demand of power has been increased ,complexity is associated with it like management and irrational tariff policies. This has affected the availability of financial resources to support investments in improving generation and transmission capacities. In such circumstances, many utilities were forced to restructured their power sectors under pressure. The restructured or deregulated system is more economical and beneficial to the consumers, but the problem of load frequency control is associated with it. The power systems are interconnected and their operation has an important aspect of load frequency control problem. In an interconnected system operation load frequency control needs the technical consideration. The area control error (ACE)has the ability to monitor the load-generation-and-frequency. On the basis of the ACE value the generating units of the system are controlled. At least after few minutes utilities have been operated in such a way that the area control error of each utility would reached to zero, meaning that the load and generation balance each other and the frequency is equal to the normal . Due to this the system performance increases but it influences the cost of the system. The increased cost is not preferable of the infrastructure, required for the feedback. From the frequency control action the wear and tear occurs on the power plant equipment. The system gives the excellent performance as all the utilities are participating in the load frequency control problem. The excellent performance justifies the increased cost of the load frequency control.

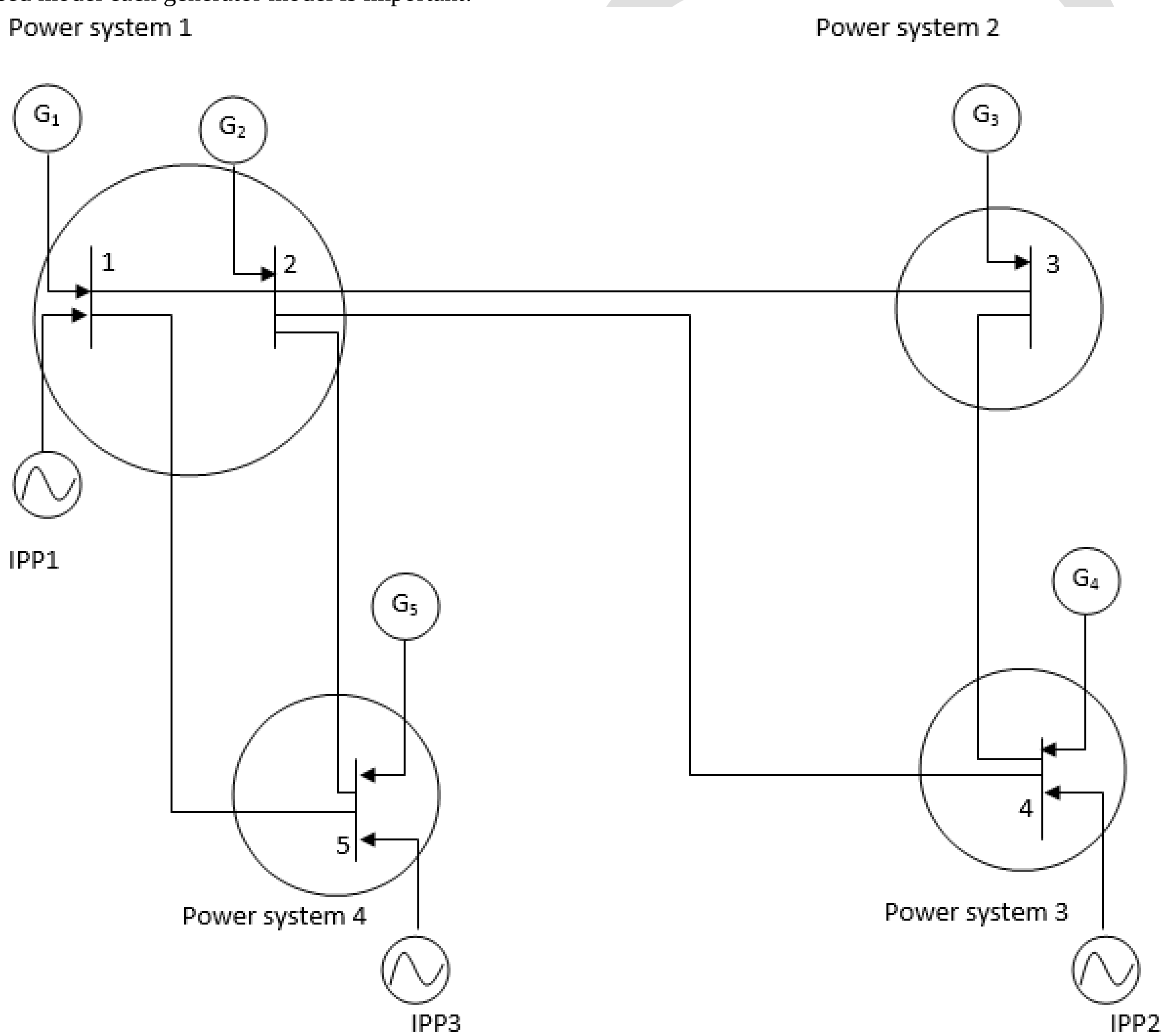
Now a days the electric utilities preferred deregulated or restructured system for trading. The load frequency control in the open market and deregulated environment has become a commodity which can be traded. In such a system the generating utilities may or may not preferred to take part in the bidding competition of load frequency control. If they will participate in the load frequency control provide service for which they must be paid or compensated. Otherwise, the generating units can apt not to participate in the load frequency control service for which they must be penalized or have to compensate the rest of the system from where supposed to received the services. Thus such a services can be offered or received by any generating unit. For such a operation the choice for real time option is available. The generating capacity participating in the load frequency control may vary in the real time. Such an operating system have the better performance. The performance of such a system is to maintain nearly constant frequency and closely monitoring the load. Thus for large deviation of load at a time the load frequency control is low compared to the load.

This paper suggests the model for the evaluation of the performance of the load frequency control problem in an environment where the units may select to offer or receive the service.

Deregulated Power System for LFC

The vertically integrated utility are not attracted by the market. For existing into the competitive environment the vertically integrated utility needs to restructured. The restructured system consists of Generating companies (GENCOs), Distribution companies (DESCOs), Transmission companies (TRANSCOs) and independent system operators (ISO). The goal is to control the load frequency in the power system i.e. restoring the frequency and the net interchanges to their desired values for each control area, still remain. For the load frequency control, a flexible method is required which should be suitable for the simulation of the operation of the system. Two specific control loops have been applied (a) utility control loop which performs economic dispatch and provides the parameters to the independent system operator for the load frequency control, and (b) the load frequency control is performed by the independent system operator control loop. The independent power producers (IPP) and utilities provide the information or parameters to the independent system operator on the basis of which it controls the load frequency in the power system. For the specific conditions the model computes the load frequency of the system. System performance is measured in two types (a) utility control error and (b) independent unit – load balance. These two types are correlated with the traditional area control error. It is observed that in order to have suitable performance, a certain percentage of the generating unit must participate in the load frequency control.

The interconnected power system is shown in the figure. The model consists of four interconnected Power systems with three independent power producers. The power system 1has two generator at bus number 1 and 2 and it is interconnected with power system 2,3 and 4 through 4 tie lines. The IPP1 is also connected at bus number 1. The Power system 2 has one generator at bus number 3 and it is connected with two tie lines to power system 1and 3.The Power system 3 has one generator at bus number 4 and it is connected to power system 1and 2 through two tie lines. The bus number 4 is also connected with IPP2. Finally, the power system 4 has one generator at bus number 5 and it is connected to power system 1 with two tie lines. The IPP3 is also connected with bus number 5. For the proposed model each generator model is important.



The model incorporates the generator circuit together with the dynamics of the generator rotor. The generator input is mechanical power and is represented by the variable $u_3(t)$. Here the voltage regulator of the generator, controls the generated voltage to a constant level. From the above equations transient analysis can be studied. The modification is needed for the proposed method. The variables available at the network level are the generator terminal voltages, currents, the rotor position $\delta(t)$ and the input mechanical power. The method is a time – domain solution that computes these quantities as they evolve with time. The meters assess the real power flow in the tie lines and the frequency of the power system at each generating plants, as the solution progresses. The different generating unit have the different frequency under transient condition at any instant of time. The area control error for this system can be computed from the tie line flows and the average of the frequency of all generators in a system. The generator who will participate in the load frequency control will be distributed by the area control error. For the independent power producer similar procedure will be followed, if they decide to participate in the load frequency control competition. If not, the mechanical power input is set to a constant level. Normally their real power output may fluctuate based on the natural response of the generator during system transient. Thus Independent system operator computes the area control error for each unit (utility or IPP) and transmits it to the appropriate party.

Conclusion

It is observed that if the number of participating generating unit in the load frequency control method is less, the system performance is not satisfactory which is unacceptable. But in the deregulated environment it is the choice of the generating unit to participate or not to participate in the load frequency control operation. It is thus recommended that there must be a minimum participation. The minimum participation depends up the system establishment. There is a need of further study to establish a minimum acceptable limit of the nonparticipating unit to the load frequency control problem.

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