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A Review on Load Frequency Control in Electric Vehicles

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ABSTRACT: As the loading in a power system is not constant so the controllers for the system must be aimed to provide quality service in the power system. The power flow and frequency in an interconnected system are well regulated by AGC. The main purpose of the AGC is to retain the system frequency constant and almost inert to any disturbances. Generally, two things are being controlled in AGC i.e. voltage and frequency. Both have separate control loops and independent of each other. Apart from controlling the frequency, the secondary majors are to maintain a zero steady-state error and to ensure optimal transient behaviour within the interconnected Areas. This paper presents a comprehensive review on the latest techniques in the design of smart controllers for load frequency control in Power Systems for Electric Vehicles as the load.

Keywords:- Multi- Area Power System., Electric Vehicles, Load Frequency Control, Machine Learning.

I. INTRODUCTION

Due to increase in emissions and depletion of fossil fuels, there has been a steady rise in the usage of EVs worldwide. They are the future of transportation. Electric mobility has become an essential part of the energy transition, and will imply significant changes for vehicle manufacturers, governments, companies and individuals. Considering a practical scenario, most consumers with EVs will visit charging stations in peak traffic hours for charging. This would lead to an impulsive and sudden increase in the load demand. Sudden increase in load would need a 'Load-Frequency-Control or LFC' mechanism to be developed for the EV infrastructure connected to the Power Systems.

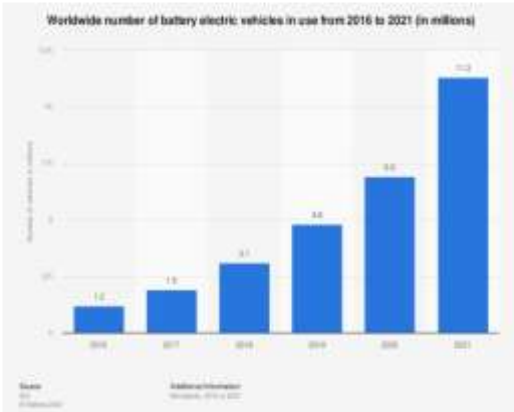

Fig.1 Rise in EV worldwide

There are several challenges associated with EV design and maintenance. The load connected to the power system is never constant, it varies continuously based on different natural and geographical conditions. This variation leads to a change in system parameters also. Since to maintain the stability of any system parameters of the power system must remain at a certain limit and follow all pre-defined constraints. Automatic generation control (AGC) is used to regulate power and frequency in the power system. AGC helps in retaining the stability of the system (both voltage and frequency) which gets affected due to disturbance or variation of load, by having a separate control loop for two.

Along with controlling frequency, it is important to keep a zero steady-state error and to ensure optimal transient behavior within the interconnected Areas. The objective is to design a controller to apprehend preferred power flow and frequency in the power system.

The input mechanical power is utilized to control the frequency of the generators and the variation in the frequency and tie-line power are detected, which is the extent of the alteration in the rotor angle. A decently outlined power framework

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ought to have the capacity to give satisfactory levels of power quality by keeping the frequency and voltage size inside the middle of as far as possible.

For the acceptable operation of a power system, frequency should remain nearly persistent. Frequency deviations can directly disturb a power system operation, system reliability, and efficiency. Large frequency deviations can damage equipment, degrade load performance, overload transmission lines. These large-frequency deviation events can ultimately lead to a system collapse. Variation in frequency adversely affects the operation and speed control of induction and synchronous motors. A considerable drop in frequency could result in high magnetizing currents in induction motors and transformers thereby increasing reactive power consumption.

II. NEED FOR LOAD FREQUENCY CONTROL

With many loads linked to a system in a power system, speed and frequency vary with the characteristics of the governor with variations in loads. No need to modify the setting of the generator if maintaining constant frequency is not needed. When a constant frequency is needed the turbine speed can be adjusted by varying the governor characteristic.

Let both generating stations are interconnected through a tie line. If the load varies at X or Y & A generation has to maintain the constant frequency, at that time it is known as Flat Frequency Regulation.

- Secondly, where both X & Y have to maintain constant frequency. It is known as parallel frequency regulation.
- Thirdly where frequency maintenance is done of a certain Area by its generator & keeping constant the tie-line loading. It is called flat tie-line loading control.
- In Selective Frequency control, individually system handles the variation in load itself & without interfering, beyond its limits, the maintenance of the other one in that group.
- In Tie-line Load-bias, control all systems in the interconnection help in maintaining frequency no matter where the variation is created. It has a principal load frequency controller & a tie line plotter determining input power on the tie for proper control of frequency.

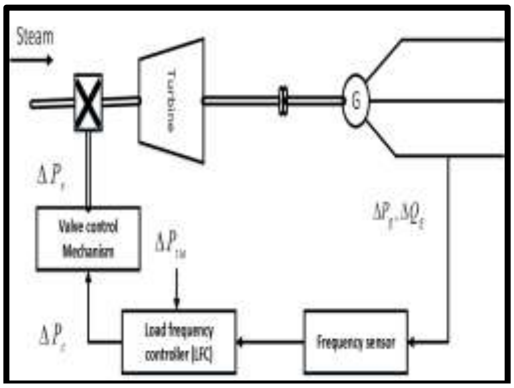

Fig.2Block Diagram of Load Frequency Control

LFC Problem in Two Area Power System

For large scale, electric power systems with interconnected areas, Load Frequency Control (LFC) is important to keep the system frequency and the inter-area tie power as near to the scheduled values as possible. The input mechanical power to the generators is used to control the frequency of output electrical power and to maintain the power exchange between the areas as scheduled. A well designed and operated power system must cope with changes in the load and with system disturbances, and it should provide an acceptable high level of power quality while maintaining both voltage and frequency within tolerable limits. Load frequency control is a basic control mechanism in the power system operation. Whenever there is variation in load demand on a generating unit, there is a momentarily an occurrence of an unbalance between real-power input and output. This difference is being supplied by the stored energy of the rotating parts of the unit.

Load Frequency Control (LFC) is being used for several years as part of the Automatic Generation Control (AGC) scheme in electric power systems. One of the objectives of AGC is to maintain the system frequency at a nominal value (50 Hz).

A power system consists of a governor, a turbine, and a generator with the feedback of regulation constant. The system also includes step load change input to the generator. This work mainly, related to the controller unit of a two-area power system. The load frequency control strategies have been suggested based on the conventional linear Control theory. These controllers may be unsuitable in some operating conditions due to the complexity of the power systems such as nonlinear load characteristics and variable operating points. To some authors, variable structure control maintains the stability of system frequency. However, this method needs some information for system states, which are very difficult to know completely. Also, the growing needs of complex and huge modern power systems require the optimal and flexible operation of them. The dynamic and static properties of the system must be well known to design an efficient controller.

III. PREVIOUS WORK

This section presents the contemporary work in the domain.

Anand et al. "Type-2 fuzzy-based branched controller tuned using arithmetic optimizer for load frequency control". This paper proposed a type-2 fuzzy proportional derivative-integral control tactic is suggested for controlling load frequency in a deregulated power system with distributed generating (DG) units and plug-in electric vehicles (PEVs). The suggested controller is tuned with arithmetic optimizer (AO) to minimize the integrated time-squared error. Practical constraints such as boiler characteristics, governor dead bands, and generation rate constraints are incorporated into the thermal system. Simulations show the superiority of the suggested scheme compared to integral, proportional-derivative, proportional-integral, proportional-integral-derivative, and type-1 fuzzy logic proportional-derivative branched with integral controllers in rejecting step load disturbances occurring in frequency deviations and tie-line power

Sevdari et al. "Ancillary services and electric vehicles: an overview from charging clusters and chargers technology perspectives". This paper proposs interconnects ancillary services and EV flexibility to help system operators (SOs) and flexibility providers understand the role and localize EV-chargers in the power system. First, the focus is on SOs. The manuscript reviews ancillary services based on power system operational challenges. Of all the different services, the ones that can be provided by EV-charger are highlighted and classified into 12 geo-electrical charging clusters. Second, the focus is moved to the flexibility providers. Independently from location, to provide ancillary services with EVs, multiple actors are recognized: the end-user, the charging site operator (CSO), the charging point operator (CPO), the aggregator, the energy community, the distribution system operator (DSO), and the transmission system operator (TSO). The collaboration between the actors is today carried out by making alliances, to help exchange knowledge and gain confidence in ancillary services provision. In conclusion, the literature review presents the characteristics of 27 slow (up to 50 kW) smart chargers, the common flexibility features being scheduling (100%), modulation (89%), and phase switching (10%).

Neofytos Neofytou et al. "Modeling Vehicles to Grid as a Source of Distributed Frequency Regulation in Isolated Grids with Significant RES Penetration". This paper examined that the fast improvement of the innovation utilized in electric vehicles, and specifically their entrance in power systems, is a significant test for the territory of electric force frameworks. The usage of the battery limit of the interconnected vehicles can carry noteworthy advantages to the system employing the Vehicle to Grid (V2G) activity. The V2G activity is a procedure that can give essential recurrence guideline administrations in the electric system by misusing the absolute limit of an armada of electric vehicles. The V2G operation can be performed either with fluctuations in charging power of vehicles, or by charging or discharging the battery. So an electric vehicle user can participate in V2G operation either during the loading of the vehicle to the charging station, or by connecting the vehicle in the charging station without any further demands to charge its battery. In this paper, the response of PHEVs with respect to the frequency fluctuations of the network is modeled and simulated. Additionally, by using the PowerWorld Simulator software, simulations of the isolated power system of Cyprus Island, including the current RES penetration are performed in order to demonstrate the effectiveness of V2G operation in its primary frequency regulation.

Tawfiq Hussein and Awad Shamekh, "Design of PI Fuzzy Logic Gain Scheduling Load Frequency Control in Two-Area Power Systems". In this paper, the utilization of the relative basic (PI) calculation consolidated with the fluffy rationale method has been proposed as an innovative gain planning load recurrence control (GLFC) in two-territory power frameworks. The proposed controller includes two-level control frameworks, to such an extent that it comprises an unadulterated vital compensator, which is associated, in corresponding with a PI controller. Therefore, the suggested approach has been examined following abnormal changes in loading conditions to clarify its reliability. The report also investigates the performance of the pure integral (I) controller and GLFC in individual configurations to highlight the advantages of the offered algorithm over the standard ones. The criterion of integral

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square error (ISE) has been exploited in the performance assessment for the designed controllers. Several simulation scenarios have been conducted, using the MATLAB–Simulink package, to illustrate the proficiency of the developed technique

T. Mohammed, J. Momoh, and A. Shukla, "Single area load frequency control using fuzzy-tuned PI controller”. This investigation expects to build up a Load Frequency Control (LFC) for a solitary zone power framework utilizing a fluffy rationale tuned PI controller. A deviation of recurrence esteem from the norm (±0.5Hz) emerges when genuine force age neglects to gracefully request alongside organizing misfortunes. Different LFC contemplates have been finished abusing control methodologies running from traditional control plans to delicate examination procedures. In this proposed examination framework elements are demonstrated in MATLAB Simulink.

S. Jennathu Beevi1, R. Jayashree, S. Shameer Kasim, “ANN Controller For Load Frequency Control”.This paper examined in this paper the Artificial Neural Network (ANN) Controller for load recurrence control of Multi-region power framework is introduced. The exhibitions of ANN Controller and customary PI controllers are looked at for Single territory and Multi-region power framework with non-warm turbines. The viability of the proposed controller is looked at by applying load unsettling influences.

V. S. Sundaram and T. Jayabarathi, "Load Frequency Control using PID tuned ANN controller in power system". This paper examined a control plan of ANN-based relative vital subordinate (PID) controller is created here to keep up the framework recurrence at ostensible worth. Because of some confusion about the present-day modern framework, the customary PID controller isn't proficient to meet our prerequisite. The neural system has an incredible ability in settling unpredictable, nonlinear scientific issues. This paper presents the structure of the neuro-PID controller model to improve the reaction and execution of a customary PID controller. This type of controller is slow and does not allow the controller designer to take in to account possible changes in operating condition and non-linearities in the generator unit. Moreover, it lacks in roubustness. Therefore the simple neural networks can alleviate this difficulty. The ANN is applied to self tune the parameters of PID controller. Multi area system, have been considered for simulation of the proposed self tuning ANN based PID controller. The performance of the PID type controller with fixed gain, Conventional integral controller, and ANN based PID controller have been compared through MATLAB Simulation results. Comparison of performance responses of integral controller & PID controller show that the neural-network controller has quite satisfactory generalization capability, feasibility and reliability, as well as accuracy in multi area system. The qualitative and quantitative comparison have been carried out for Integral, PID and ANN controllers. The superiority of the performance of ANN over integral and PID controller is highlighted.

S. Baghya Shree, N. Kamaraj, “Hybrid Neuro-Fuzzy approach for automatic generation control in restructured power system”. In this paper, a half and half blend of Neuro and Fuzzy are proposed as a controller to comprehend the Automatic Generation Control (AGC) issue in a rebuilt power framework that works under the deregulation platform on the respective arrangement. In each control zone, the impacts of the potential agreements are treated as a lot of new info signals in an altered conventional dynamical model.

D. K. Sambariya and Vivek Nath, “Load Frequency Control Using Fuzzy Logic Based Controller for Multi-area Power System”. This paper examined that Load recurrence control (LFC) is required for solid activity of an enormous interconnected force framework. The fundamental work of burden recurrence control is to direct the force yield of the generator inside a predetermined region as for change in the framework recurrence and tie-line power, for example, to keep up the booked framework recurrence and force an exchange with different territories in an endorse limits. In this paper, the investigation of the LFC framework for single territory and twofold zone non-warm framework is done.

G. Chun-lin, et al. "Impact of electric vehicle charging on power grid”. This paper talked about while the quantity of interior ignition vehicles is deteriorating, and is even expected to diminish in a couple of decades, the measure of electric vehicles is anticipated to increment. A large portion of the electric vehicles are intended for day by day urban use, along these lines sooner rather than later, greater urban communities may have exactly ten level of electric vehicles running on their avenues during the day.

S. K. Jain, A. Bhargava, and R. K. Pal, "Three area power system load frequency control using fuzzy logic controller". This paper examined that Load recurrence control has been utilized widely in power frameworks. The heap recurrence control has an incredible bit of leeway as far as cost and unwavering quality. This paper presents a heap recurrence control strategy dependent on the Fuzzy Logic Controller (FLC). The primary target is to plan a powerful controller that can guarantee great execution.

IV. CONCLUSION:

It can be concluded from previous discussions that Load Frequency Control (LFC) is used to regulate and control the output frequency signal of the electrically generated power within an area in response to changes in system loads. This work discusses the effect of electric vehicles on the load frequency deviation. This paper presents a systematic review on the various smart optimization techniques for load frequency control especially targeted towards electric vehicles connected to Power Systems.

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