Research on Optimal Operation of Electrical Power System

Hui Fang [a], Qun Liu [b], Shaopeng Yan [c], Jingsong Wang[d]

State Grid Henan Electric Power Company Luoyang Power Supply Company,

Luoyang 471000, China

[a]yshp-yshp@163.com,[b]1015903240@qq.com

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Abstract. It would create great economic benefits if the operation of a power system be optimized due to large amount of input and output, so is has become one of the most important topics for electrical utilities. Among various problems in optimal operation of power system, power flow analysis is a fundamental one, making the optimization results more compatible with the operation of real power system; medium/long-term unit commitment (UC) is an expanded problem of classic short-term unit commitment, to realize a more economic UC result in a longer time horizon; optimal operation of energy storage system is a problem accompanied with the development of power system. Therefore, the work of this dissertation is based on the above-mentioned aspects.

1. Introduction

Power system is one of the modern societies the largest and most complex engineering system, which optimizes the operation, has long been an important topic of power industry, being highly valued. In recent years, China's energy demand continues to grow rapidly, fossil energy consumption of large quantities of pollutants and greenhouse gas emissions resulting serious impact on the environment, forcing China's economic growth mode from extensive to intensive. Electric power industry as a large input, large output of the production run, optimizing all aspects of operation to save a little, running costs of the entire system, energy consumption is of great significance. Therefore, the use of limited resources, improve operational efficiency, so that the power system as much as possible to achieve operation optimization, the adjustment of China's power structure and the optimal allocation of resources, sustainable development and even the national economy has important strategic significance.

"Optimal operation of the power system" in a narrow sense is a branch of power system analysis, "Optimize Run" from a certain point of view has become a term, its main task is to meet the electricity needs of the user and system security premise, reasonable arrangements for power operating mode to get good economic returns. So traditionally "Optimize Run" economic dispatch of power systems based on the analysis, including active power optimization scheduling, reactive power optimization scheduling, economic dispatch, optimization trends, unit commitment and Hydrothermal joint optimization problems. Broadly, the process in many aspects of power system operation are related to optimization problems, such as distributed power supply planning, distribution planning grid, the optimal cutting machine cutting load program, charging and discharging of the energy storage system programs, through the establishment of appropriate optimization model using appropriate optimization algorithm to optimize the results, so as to improve the efficiency of the economy or of the investment in equipment and other purposes.

2. Research on The Long-term Unit Commitment

Present global electrical energy is still the main thermal power accounted for 68%, China is as high as 75%, followed by nuclear power and hydropower. Optimize the operation of the power system to consider not only the short-term optimization of resources should be based on long-term optimization of resources. UC problem is to arrange the long-term plan to set off on over a longer period of study, so that the power balance in meeting the standby requirements set the minimum

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opening downtime at minimum load unit and a series of constraints, the total system operating costs minimum. UC has been the operation of the power system optimization important content and research focus. As a large-scale, mixed-integer nonlinear combinatorial optimization problem, the problem of short-term UC often a day study period, both in terms of the model and in solving methods have been more mature. UC issue long-term resource optimization can be achieved for a long time, but just short-term UC questions on time scales of a simple extension, but also need to consider more decision variables, constraints, coupled stronger, often need to use solution simplified means to solve refined, is a topic worthy of further study.

In recent years, in response to environmental stress, energy generation scheduling in the power system more and more attention, the country's main method is to use the difference in power principles. Capacity is the difference in the longer scheduling period, not when used according to the traditional dispatching "Three Principles" power distribution between units, but the distribution of electricity according to the characteristics of the particular unit is the unit of contaminant emission difference, increasing performance good utilization of the unit, reduce the utilization of poor performance of the unit, in order to achieve energy conservation. So consider differences in the implementation of electricity have practical significance and long-term problem in combination Unit. Also in the actual operation of the unit to contribute to long-term at a low level will affect the life of the unit and run the economy, in order to take into account the principle of fairness in a competitive environment within the study period all units of output level should be higher than a certain value.

Solving unit does not consider short-term utilization of the thermal unit is already quite mature, such as literature, preclude the use of mixed integer linear programming objective function and constraints are solved linearization achieved good results, mixed integer linear programming with global best excellent and modeling flexible benefits. In theory, the above difference in the establishment of the unit and the unit output power level constraints are already bound by the constraints of linear combination of problems and long-term unit can also be used mixed-integer linear programming method to solve it. But with the increase of the study period, the unknown variables and constraints have increased exponentially, along with the time required to solve the exponential growth; From the mathematical model unit utilization constraints such constraint is coupled with respect to time constraints this coupling constraint has increased the difficulty of solving such solution efficiency can not be guaranteed. Based on this decomposition of thinking, we will set the time depends on the utilization of constrained de-bonded fine, the combination of long-term issues to be unbundled units to solve it.

3. Offline Optimize Battery Energy Storage System

Battery energy storage system has a high energy density, high efficiency, flexible installation location advantages. The development of battery storage technology development in China in recent years is very rapidly. BESS access to a single distribution network load shifting as the main functional orientation, and both consider optimizing Distribution Network loss offline optimization operation. Loss is an important economic indicator ,, independent of the power grid and run a business at a given load curve and the energy storage device capacity parameter access point load shifting effect and energy storage power station, making the net loss become storage One of the important reference factor station access points decision. Currently optimization operation battery energy storage system to optimize load shifting load curve often targeted, but rarely as battery energy storage station network loss optimization considerations of operational strategy formulation.

Optimization in a single run on the basis of further consideration of the distribution network is high wind integration rate of offline operation comprising a plurality of optimization. Due to increased energy efficiency is one of the important functions of renewable, thus optimizing operational objective in considering load shifting load curve optimization taking into account the amount of wind minimize abandoned. The outer layer of the state of genetic algorithm optimization is inner quadratic programming method to solve it. Genetic Algorithm ideas are similar to the previous section, except that the single exhibition to multiple will not be described here. Since the

increase in the number of variables, constraints also changed, quadratic programming model also corresponds with the former quite different.

In only one case BESS can be used directly as the variance of the power curve to achieve the objective function BESS load shifting, quadratic programming at this time the inner layer is convex quadratic programming algorithm has been very mature; BESS can run No load curve and achieve the purpose of reducing net loss of features related; distribution network of grid loss can be used as a reference BESS access point. When there are multiple BESS, the direct use of the variance of the power curve as a function of load shifting goals do not have convex quadratic programming, this paper obtained by correcting the objective function reasonable assurance convexity of quadratic programming, and good too achieve the purpose of load shifting and increase renewable energy utilization.

4. Multi-storage System Operation Optimization

Storage configuration in two ways: centralized and distributed. Although the configuration of distributed energy storage dispersed, but if coordinated control from the functional equivalent is a large energy storage system. This large storage capacity and energy power systems theory is a superposition of the small capacity energy storage system, so you can better achieve peak load shifting, inhibition of renewable energy power generation fluctuation, stable voltage fluctuation, adjust the frequency and so on.

Analogy different time scales of generation scheduling, optimal operation of energy storage systems also require multiple time scales is controlled in order to achieve a comprehensive optimization run. The last chapter discusses many of the great potential for development of energy storage technology battery energy storage system to load shifting as the basic functional orientation combined with offline optimization operation of other goals, with the predicted load curve developed before or hours before the charge discharge strategy. However, regardless of battery energy storage systems or other types of energy storage systems in real situations require further optimization control. Unlike centralized storage systems, real-time control strategy paper aims to study multiple distributed real-time run-time storage system to meet the requirements of power system operation, operating results in the offline optimization based on real-time coordination of optimal control strategy.

DESS coordination optimization frequent exchange of information between the control of real-time requirements of each DESS, it is assumed that the communication network to 达 DESS connected to the automatic control purposes. When the number and location DESS more widely distributed, preclude the use of distributed optimization control mode compared to more centralized control mode to optimize this advantage is due to touch compared to a distributed control, centralized control mode has the following disadvantages: connection DESS Communication higher network costs, centralized control mode to set the central controller to gather global information about all DESS to formulate a unified control policy and control commands transmitted to each DESS; this mode inflexible, difficult to meet the Plug and Play It needs. Using a distributed control mode, all DESS respective local communication network to obtain information from their own control algorithms make decisions based on appropriate optimization, integrated together to achieve real-time coordination of multi DESS optimization control.

5. Summary

Economic growth mode from "extensive" to "intensive" to optimize the operation of the power system put forward new demands. As an important branch of power systems research, optimize the operation of the power system is a huge task, and therefore some of the contents of this article is based on research. To further optimization of power system operation, results of previous studies on the base sleeve, first try using algebraic geometry method for power system load flow study this fundamental issue; secondly to establish long-term sub-step model for solving the touch type according to the operating characteristics of the power system in combination with the idea of the

establishment of decomposition; and finally run the optimization of both offline and real-time study of the energy storage system levels.

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