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Quantum genetic algorithm for dynamic economic dispatch with valve-point effects and including wind power system

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ABSTRACT

An optimization algorithm is proposed in this paper to solve the problem of the economic dispatch that includes wind power generation using quantum genetic algorithm (QGA). In additional to the detail introduction for models of general economic dispatch as well as their associated constraints, the effect of wind power generation is also included in this paper. On the other hand, the use of quantum genetic algorithms to solve the process of economic dispatch is also discussed and real scenarios are used for simulation tests later on. After comparing the algorithm used in this paper with several other algorithms commonly used to solve optimization problems, the results show that the algorithm used in this paper is able to find the optimal solution most quickly and accurately (i.e. to obtain the minimum cost for power generation in the shortest time). At the end, the impact to the total cost saving for the power generation after adding (or not adding) wind power generation is also discussed. The actual operating results prove that the algorithm proposed in this paper is economical and practical as well as superior. They are quite valuable for further research.

1. Introduction

The reserve for fossil fuel such as coal, petroleum and natural gas is limited. The energy on which mankind depends for survival and development will dry up someday eventually. Also, the environmental pollution and safety problem caused by the forever growing energy consumption has become the whereabouts of an important, outstanding, key issue to the society. Whether seeing it from the point of view of the future energy crisis of the mankind or the current environmental pollution problem, it is of great significance to research and develop wind power generation technology. Also, the wind power resources on earth are rather abundant and therefore, the prospect for development is quite rosy.

The operation of large scale grid of wind power farm is the primary format for the world to use wind energy. As the science and technology progresses, the capacity from a large quantity of new wind power farm can be comparable to that of conventional units. Wind energy is an inexhaustible energy, which can be used to generate electricity without the consumption of fuel and can save fuel cost for the power system. But on the other hand, wind energy is random, which increases the uncertainty during the operation of power system and presents new challenges to the economical operation of power systems.

The theme of this paper is to study the economic dispatch problem for power systems which contain wind power generation plants. The economic dispatch for traditional power systems can be divided into static optimal dispatch and dynamic optimal dispatch. The static optimal dispatch only seeks to achieve an optimal objective for the power system at a specific time, but will not take into account of the intrinsic link between system at different time moments; while the dynamic optimal dispatch takes into account of the coupling effect of system at different time moments, such as the limit on the climbing rate of a generator. As a result, its computation process is more complex than that of a static optimal dispatch, but the computation results are more in line with actual requirements. Because wind speed changes randomly, it is more suitable for the economic dispatch of power systems containing wind power farm to adopt dynamic models. When using dynamic economic dispatch, it is necessary to know the output data of the wind power farm at every moment in the optimal duration. Currently, it is rather difficult to predict the output of a wind power plant. Although there are some research development in this area abroad, in general, the error of predicting output for a wind power farm is rather large, which increases the difficulty for economic dispatch.

In the past, there are many methods can be deployed to solve the economic dispatch problem, for example: Dynamic programming [1,2], the advantage of which is that the cost function can be discontinuous or non-monotonically increasing and the disadvantage is when the number of units increases, its computational

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