计及需求响应的有功优化调度研究

摘　要

　　随着用电负荷的急剧增长和新能源占比的日益上升，仅依靠发电侧资源已无法应对如此庞大的电网压力，在这种情况下需求侧响应开始引起人们的关注。在传统的电力观念中，需求侧资源通常被视为物理上的负荷，无法根据系统需要做出相应变动，但随着电力市场化改革的不断深入，需求侧响应成为一种可能并逐渐为世界各国所应用。基于以上背景，本文对计及需求响应的有功优化调度做出如下研究：

　　（1）选取改进后的分支定界法作为混合整数规划模型的求解算法，并对其计算原理和流程进行分析。通过将自行编写的算法程序与求解器调用程序进行比较，发现求解器更具优势，所以最终决定使用 yalmip 工具箱对 cplex 求解器调用求解。

　　（2）以总成本最小为目标函数，建立包含火电机组、可中断负荷和直接负荷控制的混合整数规划模型，在对可中断负荷和直接负荷控制的作用进行初步分析后，加入风电并以总成本最小和弃风量最小为目标函数进行二次求解，探究风电并网对系统运行的影响以及需求响应的改善作用。

　　（3）由实际算例分析可知，可中断负荷和直接负荷控制可以通过替代部分备用机组，优化备用容量配置，减少总成本；弃风率与总成本的矛盾关键在于风力波动要求系统具有相当的爬坡速率和备用容量，而可中断负荷与直接负荷控制提供了大量廉价备用，既可以减少总成本，又可以降低弃风率，实现"双赢"。

关键词：需求响应；分支定界法；可中断负荷；直接负荷控制；风电

ABSTRACT

With the rapid increase in electrical load and the increasing proportion of new energy sources, the power generation side alone can not cope with such enormous stress on electrical grids. In this case, the demand response has begun to attract people's attention. In the traditional concept of power, demand-side resources are usually regarded as physical loads and can not be changed according to the needs of the system. However, with the continuous deepening of the electric power deregulation, demand-side responses have become a possibility and gradually are applied by various countries in the world. Based on the above background, this paper makes the following research on active power optimization dispatching which takes into account demand response:

(1) This paper selects the improved branch and bound method as the solution algorithm for the mixed integer programming model, and analyzes its calculation principle and calculation process. By comparing the algorithm programs written by myslef with the programs of calling the solver, it is found that the solver has more advantages, so this paper finally decides to use the yalmip toolbox to call the cplex solver for the purpose of solving.

(2) With minimizing the total cost as the objective function, this paper establishes a mixed integer programming model, including thermal power units, interruptible load and direct load control. After the preliminary analysis of the effect of interruptible load and direct load control, this paper adds wind power to the model and gets the solution with minimizing the total cost and minimizing the wind curtailment as the objective functions to explore the effect of connection of wind farms with power grid on the operation of the system and the improvement of demand response.

(3) From the analysis of practical examples, it is known that interruptible load and direct load control can be used to replace part of the standby units to optimize the configuration of reserve capacity and reduce the total cost. The key to the contradiction between the rate of the wind curtailment and the total cost lies in the

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