The Design of the Trading Mechanism to Adapt the Development of Mixed Cooling Heating and Power

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Abstract. The enterprise who has combined cooling heating and power system has both the customer group and the power generation resources. Therefore, it can be used as a power user, and can also be used as a power generation enterprise to participate in the direct purchase of electricity. This paper combines characteristics of mixed cooling heating and power, designs application business model of mixed cooling heating and power, and puts forward to the scene of cooling heating and power trading scheme, helping the enterprise according to the power supply and demand situation in the region adjust their positions and participate in the electricity market.

1. Introduction

Since 2015, the state promulgated the "on the further deepening of power system reform opinions "," cogeneration management measures “, and " on the "Internet plus" wisdom energy development guidance development and reform energy [2016]392 ", putting forward to encourage the development of distributed power projects and promoting the development of CCHP with distributed power. In the market-oriented reform, energy trade shows trade diversification, commodity diversification, diversification of user selection characteristics and transaction information transparency. The reasonable and efficient design of thermoelectric integrated energy trading mechanism is the key to optimizing the energy development, transfer and utilization. And it also embodies the important means of comprehensive value of energy.

2. The concept and characteristics of mixed cooling heating and power

2.1. The concept of mixed cooling heating and power

CCHP is the set of small scale energy supply system which is relative to the traditional centralized power supply. Its generation system builds around the user based on decentralized and small scale, which can effectively reduce the energy loss in the conveying process when electricity, heating, and cooling are transported in the long distance and reduce the investment of distribution system. It also can provide high quality, high reliability and clean energy services for neighboring users.

The traditional combined cooling, heating and power mostly relies on natural gas, coal and other single energy, which makes combined cooling, heating and power limited by geographical,

environmental, cost and other aspects. With the thermoelectric cooling heating and power putting forward, a new idea about a new regional CCHP application and construction has been presented, which will make all kinds of energy and information flow together to form an efficient energy utilization system.

From the energy structure, mixed cooling heating and power is not a single energy supply, but, according to local conditions and customer demand, makes the natural gas, wind, light, heat, biomass and other types of geothermal energy match and schedule.

Analyzing source of fuel, the distributed power supply system which uses renewable energy such as solar and wind energy as fuel, due to the free source of fuel, has the most significant economic efficiency, but there are also defects of energy supply instability caused by some insuperable conditions such as environment, climate, day and night. Natural gas distributed energy supply is stable and sustainable. But due to the highly current domestic gas prices, difficult access and low electricity prices, it is difficult to operate normally, if there is no government subsidies and support.

In view of this, we can build distributed mixed cooling heating and power system by taking natural gas distributed energy as the core and taking solar and wind energy, biomass energy, geothermal energy and other renewable energy as auxiliary. This system can ensure the continuity and stability of energy supply, but also can reduce the cost of fuel system in a certain extent, so it is an ideal thermal energy mix application mode.

2.2. The characteristics of mixed cooling heating and power

Distributed mixed cooling heating and power system is a new type of energy system, which integrates high technology and equipment, realizes the cascade utilization of output energy and achieves higher energy efficiency. The development of mixed cooling heating and power system can improve energy efficiency and reduce environmental pollution. It not only plays a positive role for the development of smart grid, strengthening energy security and optimizing the energy structure, but also provide effective technical means to a drastic reduction in the short-term energy consumption.

Mixed cooling heating and power system contains a variety of micro power, such as distributed photovoltaic power generation, fuel cell, gas engine and gas turbine CCHP and other forms of power generation, and electric energy storage and heat storage (cold) device. These micro powers have different power generation characteristics, and some micro power generation characteristics have complementary advantages. The different energy flow between the distributed mixed cooling heating and power system and the traditional power supply system is shown in Figure 1.

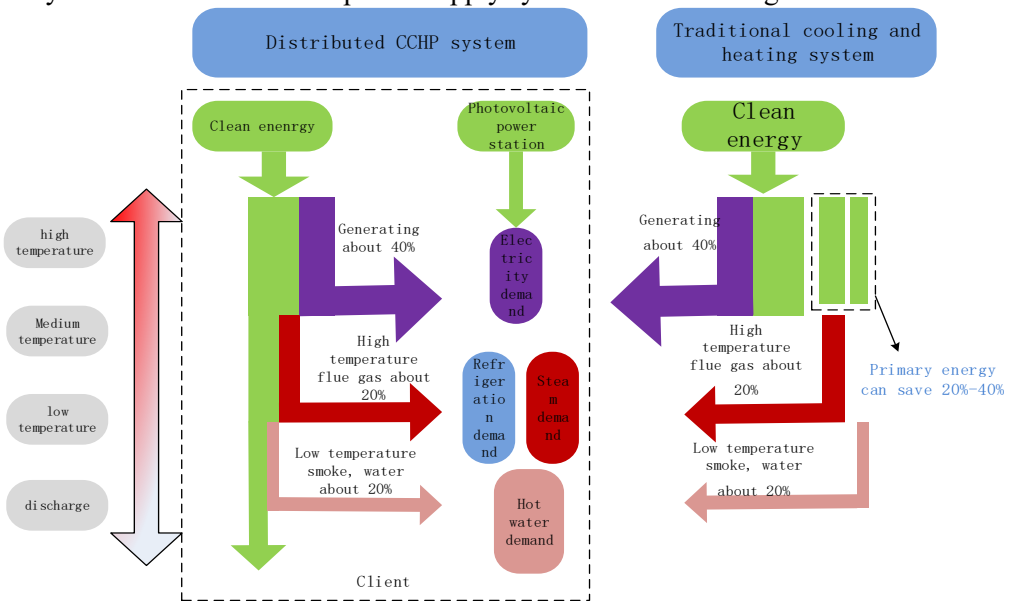

Figure 1. Comparison of different energy supply modes

3. Design of mixed cooling heating and power trading mechanism

3.1. Electricity trading mechanism servicing energy saving and emission reduction targets

3.1.1. Transaction mode. There are mainly three types of trading in the electricity market: bilateral negotiation, centralized matchmaking and centralized listing.

Bilateral negotiation. By the end of the power users (the buyer) and sending end power enterprises (the seller), following the principle of equality and voluntary, independently negotiate direct trading intention (including transaction quantity, transaction price, execution time, the default power compensation standard and other content), and submit to electricity trading platform within the prescribed time. Then through the power trading center verifying and the electric power control center security checking, the constraint trading results could be formed.

Centralized matchmaking. By the end of the power users (the buyer) and sending end power enterprises (the seller) through the electricity trading platform centrally declare transaction demand, and then the power trading platform follows the principle of clearing transactions to match trades, forming unconstrained trading results. Then through the power trading center verifying and the electric power control center security checking, the constraint trading results could be formed.

Centralized listing. Electricity trading platform, according to the cross inter provincial direct trading and transaction price electricity released market information and subscription electricity that seller (buyer) through the electricity trading platform declare, determines the transaction electricity volume by the power distribution principle, forms unconstrained trading results. Then through the power trading center verifying and the electric power control center security checking, the constraint trading results could be formed.

3.1.2. Transaction types. According to the transaction cycle, the power market can be divided into annual trading and monthly trading, day-ahead trading and real-time trading.

Annual trading. The enterprise of mixed cooling heating and power, as a seller, declares the next year available electric quantity and price at the end of each year and does bilateral negotiation or centralized trading with the buyer outside area. As a buyer, the enterprise declares next year's demand electric quantity and price at the end of each year and does bilateral negotiation or centralized trading with the generation enterprises outside area.

Monthly trading. The enterprise of mixed cooling heating and power, as a seller, declares the next month available electric quantity and price at the end of each month and does bilateral negotiation or centralized trading with the buyer outside area. As a buyer, the enterprise declares next month's demand electric quantity and price at the end of each month and does bilateral negotiation or centralized trading with the generation enterprises outside area.

Day-ahead trading. According to the day-ahead load forecasting results and output capacity of the unit, the enterprise of mixed cooling heating and power participate in the day-ahead trading. The enterprise, as a seller, declares the next day new supply of electricity and prices before the daily 12:00, and makes bilateral consultations or centralized transactions with the buyers outside area before 16:00, finishing the completion of centralized bidding. The enterprise, as a buyer, declares the next day new demand of electricity and prices before the daily 10:00, and makes bilateral consultations or centralized transactions with generation enterprises outside area before 16:00, finishing the completion of centralized bidding.

Real-time trading. Based on day-ahead trading, when the power supply and power demand still exist deviation, the real-time trading should be started. That is: when power market is in short supply, power grid support is looked for. When power market is oversupply, margin surfing is looked for.

3.1.3. Electricity trading mechanism servicing energy saving and emission reduction target. Based on the existing power trading mechanism, modified electricity trading mechanism servicing energy saving and emission reduction targets improves the mixed cooling heating and power bidding

competitiveness mainly by changing the bidding and bid collation calculation method. So, success rate of power trading of the mixed cooling heating and power and the clearing price can be improved.

Bidding sorting considering emission reduction benefits. Electricity trading center calculates environmental benefits that unit generating capacity of mixed cooling heating and power generates (pollutant emission reduction generates the environmental benefits. The calculation method: pollutant emission reduction in unit generating capacity * Unit pollutant emission abatement cost), making the quote price reduce environmental benefits as the final bid participate in the bidding.

Bidding sorting considering energy saving. When the price declared by the seller (considering the benefits of mixed cooling heating and power) is same, we can sort the price and quantity, according to the priority of coal consumption rate, the priority of the cogeneration unit, etc.

3.2. Electric auxiliary service trading mechanism

3.2.1. Ancillary service types. The auxiliary service types that power generation unit provides for the power grid are: automatic power generation control (AGC), rotating standby (hot standby), shutdown standby, reactive power and voltage support, recovery and black start, etc.

3.2.2. Market trading process. The operation of the market is carried out based on the trading day, and each trading day is a calendar day. The calendar day is divided into 48 trading periods and each trading periods lasts 30min. When the spot market shows demand, the electricity trading center releases the market members of the total demand for ancillary services market at the same time.

All auxiliary service licenses are issued before 2:00 pm. According to the size of the ancillary services market, the electricity trading center determines the market trading scheme and the market clearing price, and releases before 5:00 pm.

3.2.3. Bidding rules. For all kinds of ancillary services, the electricity trading center orders the reporting units from low to high, and low prices are the priority procurement. For the sake of system safety and reliability, the power exchange center can change the priority of some units. If the above situation is shown, the electricity trading center must provide reasonable analysis and interpretation, and file for future reference. Combined cooling heating and power enterprises can quote price based on their actual.

3.2.4. Trading mechanism. Electricity trading center organizes FM service, operating reserve, alternative standby and cold standby market every day. The enterprise of mixed cooling heating and power can declare several ancillary services at the same time.

FM service (AGC): in any trading session, positive FM capacity of units is the difference between adjustment upper limit (100% rated capacity) that mixed cooling heating and power units report and the base value. And the negative FM capacity of units is the difference between adjustment lower limit (0) and the base value.

Cold standby: cooling heating and power gas turbine start and stop fast, has low cost and is suitable for cold standby. At any trading period, the units that have been involved in market competition but failed to run the network can all be the cold standby of power grid.

Voltage and reactive power support and black start service: According to the operating cost of FM unit and the contribution to the stability of the system frequency, the power exchange center pays reasonable fees for each FM unit. When the power system collapses, mixed cooling heating and power cogeneration unit has the obligation to provide the black start services. Give some incentives to contributor that helps system recovery and penalize those cause the system to crash or hinder system restore.

3.2.5. Settlement assessment. In the ancillary services market, enterprises of mixed cooling heating and power declare capacity bid price of each service and electricity price bidding. After the success of the

bid, the company will reserve generating capacity and get capacity payment. In real-time scheduling, if the enterprise is called in real-time, then a certain price of electricity will be paid. Therefore, enterprises of mixed cooling heating and power can get two aspects of the cost of power grid corp.

3.3. Other forms of energy trading mechanism

3.3.1. Thermal trading mechanism. When the supply of heating power that enterprises of mixed cooling, heating and power offer cannot meet the needs, or fault or overhaul of the units happen, the enterprises need to buy the heating of thermal power plant or need to be heated by the municipal thermotic Inc.

When the municipal thermotic Inc directly supplies heating, the heat price follows the unity guidance price of the government's implementation. When the cooling heating cogeneration hybrid energy companies playing an energy service provider role participate in the transaction of thermal power plant and sign a thermal purchase contract, heating transfer can be done according to the index of the supply and demand situation, heating capacity, heating price negotiation.

3.3.2. Carbon trading mechanism. The cooling heating cogeneration hybrid energy companies can effectively reduce carbon emissions, which can be reserved for the next year or participate in carbon trading market. Relevant provisions follow the relevant transaction mechanism of carbon trading market. The companies consider the transaction prices of carbon trading market and supply and demand situation, declaring the carbon price and trading volume, in which the carbon trading volume cannot exceed the saving carbon quota. Carbon trading center following the high and low matching principle sets up a carbon transaction between the two sides to reach a deal, and gets a clear price of carbon trading.

4. For multi scenes of trading portfolio of mixed cooling heating and power

Driven by cost benefit optimization, the cooling heating cogeneration hybrid energy companies will actively adjust the operation of units, adjust the power output unit according to the power demand, and actively participate in the electricity market, reducing purchasing cost and increasing the generating income.

In the night, when cooling and heating demand is low, the gas turbine is shut down. At the same time, enterprises can be used as cold standby or rotating standby. In the peak period, we can adjust the operation mode set and guide users to participate in demand side response, realizing the cut peak fill valley in electricity. At any time, cooling heating and power units can provide black start service, and according to the operating conditions, improve the frequency control services.

For multi scenes of trading portfolio of mixed cooling heating and power is shown in Figure 2.

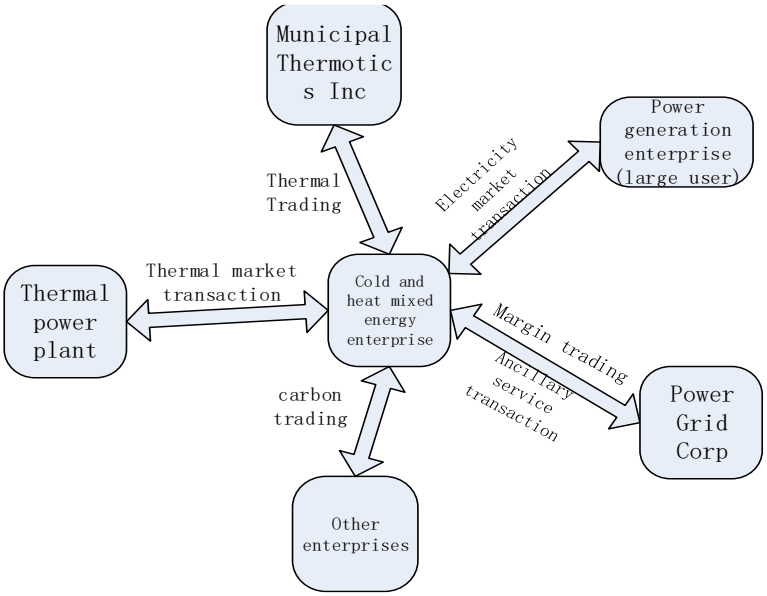

Figure 2. For multi scenes of trading portfolio of mixed cooling heating and power

5. Conclusion

Mixed cooling heating and power can effectively improve energy efficiency, ease the impact of distributed generation on the power grid, and promote the development of distributed PV and other clean energy. For the electric power industry, the combined cooling, heating and power supply enterprises, users and the whole society, it can bring huge economic benefits and good development potential. This paper combining the characteristics of thermoelectric energy mix, designs the trading mechanism of such energy systems, including the service of energy-saving emission reduction targets, ancillary service trading mechanism and other forms of energy trading mechanism, and gives the heating and power for multi scene's energy trading scheme. So, we can improve the investment enthusiasm of enterprises, and make such resources play a role in promoting the optimization of energy saving and emission reduction in our country and the development of low carbon economy in the process.

References

[1] Duan Shaohui, Wang Wei, Liu Zhongsheng. Optimal scheduling scheme for micro-network system with hot and cold heat and electricity according to photovoltaic [J]. Journal of Electric Power Systems and Automation, 2013,8 (4): 150-155

[2] Zhang Tao, Zhu Tong, Gao Naiping. Study on optimal design of distributed hot and cold energy system and multi-index comprehensive evaluation method [J]. Proceeding of the CSEE, 2015,7 (14): 3706-3713

[3] Wang Cheng, Xu Yancai, Wei Qinglai. Analysis of business model and operation strategy of intelligent community [J]. Power System Protection and Control, 2015,3 (6): 147-154

[4] Zhang Shengtao. Natural gas cogeneration system performance analysis and system optimization [D]. North China Electric Power University, 2015.

[5] Liu Ye. Optimization Design of Distributed Cogeneration System [D]. North China Electric Power University, 2012.