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Research on wind power consumption enhancement strategy based on cooperative scheduling of cogeneration units

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Introduction

Current issues

1. Thermal power units prioritize determining heating output based on thermal demand
2. Unit heating during the heating period reduces the grid's peaking capacity

Current methods

1. Adding heat storage devices and modeling thermoelectric coupling relationships
2. Modeling the thermal network, study of constraints on the operation of thermal networks
3. Allocation of electrical loads using thermoelectric relationship curves

Our method

This paper builds a thermoelectric cooperative scheduling support system based on the smart grid scheduling support system, collects power plant data in real time through the scheduling data network, and realizes cooperative and optimized distribution of electric loads of thermoelectric units.

Cogeneration unit constraints

In fig.1, ABCD are typical feasible region forms of thermoelectric units

Along the AB characteristic, the thermal power and electrical power of the thermoelectric unit exhibit inverse regulation characteristics

Along the BC characteristic, the electrical power and thermal power are proportional.

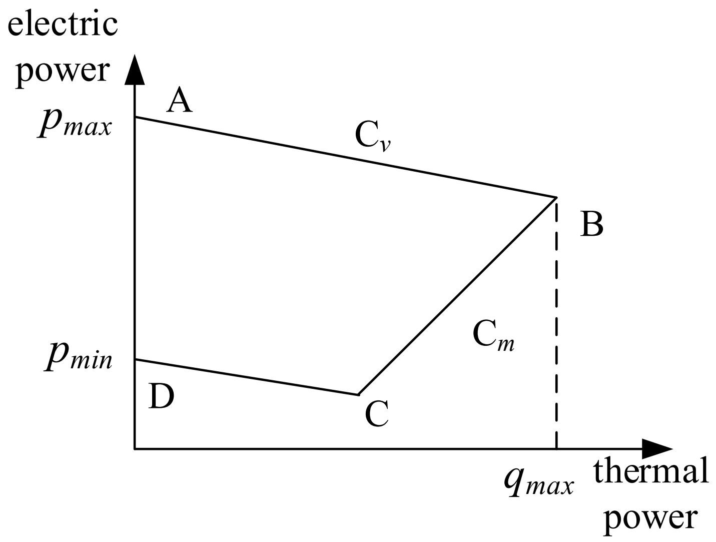

Fig.1 Schematic diagram of feasible region of cogeneration unit

$$
\begin{cases}
p_{chp,t} \geq \max\left(p_{chp,\min} - C_v q_{chp,t}, C_m q_{chp,t} + C_k\right) \\
p_{chp,t} \leq p_{chp,max} - C_v p_{chp,t} \\
0 \leq p_{chp,t} \leq q_{chp,\max}
\end{cases}
$$

The formula is described as shown above

$p_{chp,t}$:Power generation at time t

$q_{chp,t}$:Heating power at time t

$p_{chp,min}$:Maximum power generation under pure condensing conditions

$p_{chp,max}$:Minimum power generation under pure condensing conditions

$q_{chp,max}$:Maximum heating power

C_v:Reduction of generated power per unit of heat supply

C_m:Elasticity coefficients for electric and thermal power

C_k:Constant

Cogeneration Co-scheduling Support System

The hardware system consists of pre-servers, computing servers, and workstations. It also needs to do data interface with wind power prediction system and AGC system.

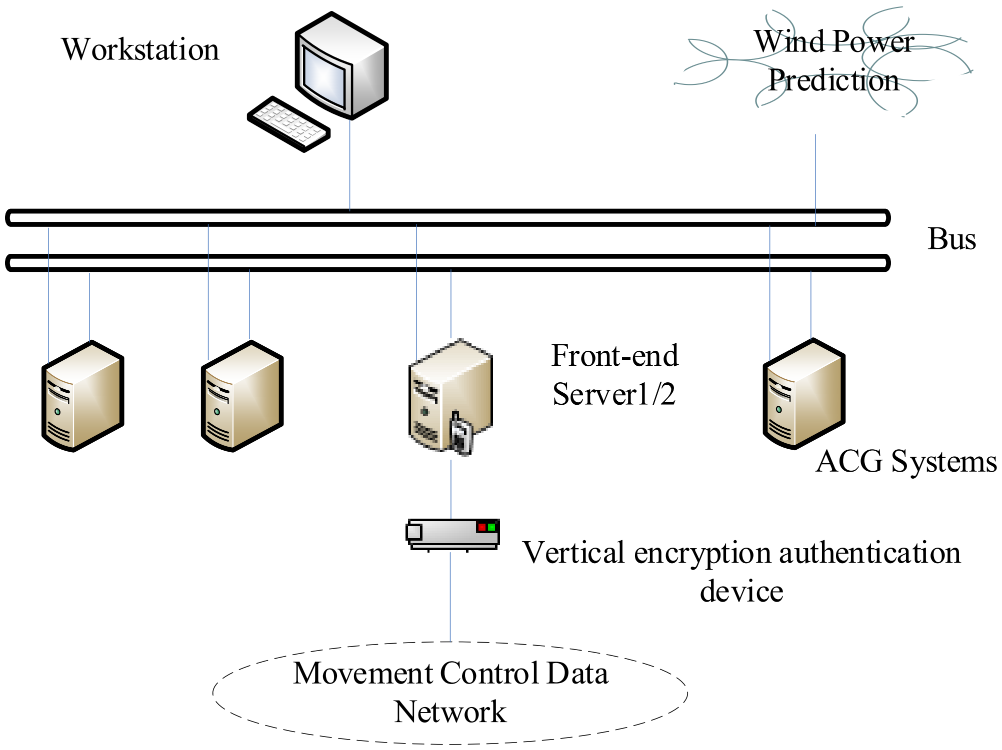

Fig.2 hardware structure

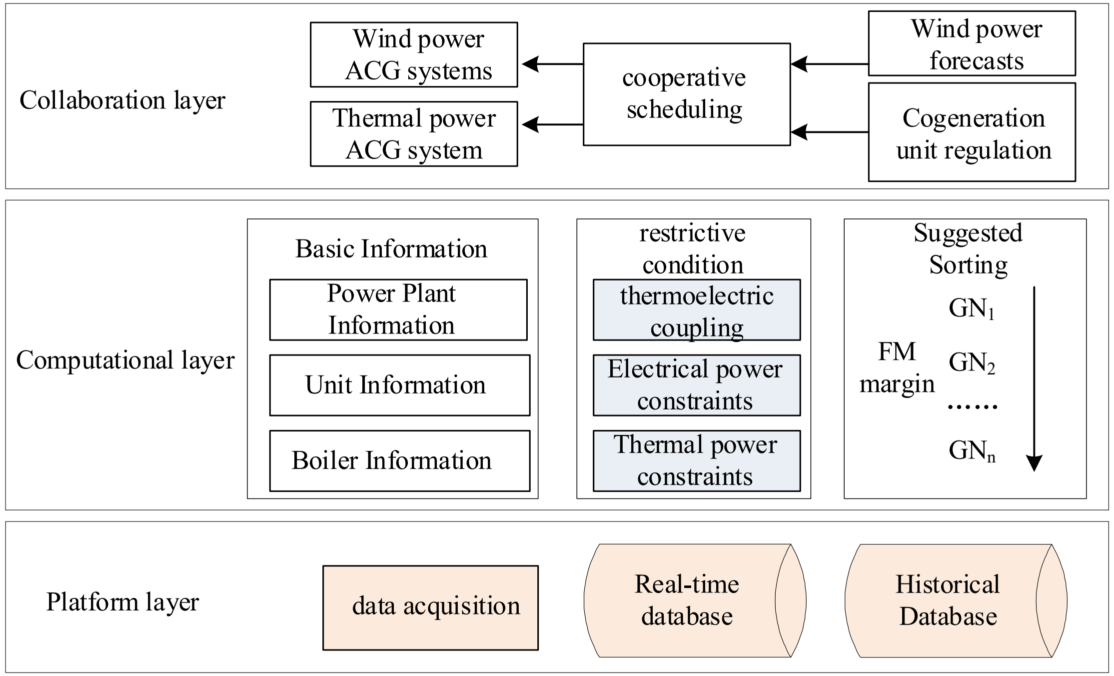

Fig.3 Heat and power cooperative dispatching support system

Platform layer: data collection

Calculation layer: calculate the adjustable interval of electric power of thermoelectric units

Co-ordination layer: optimized allocation of electric power

Examples of applications

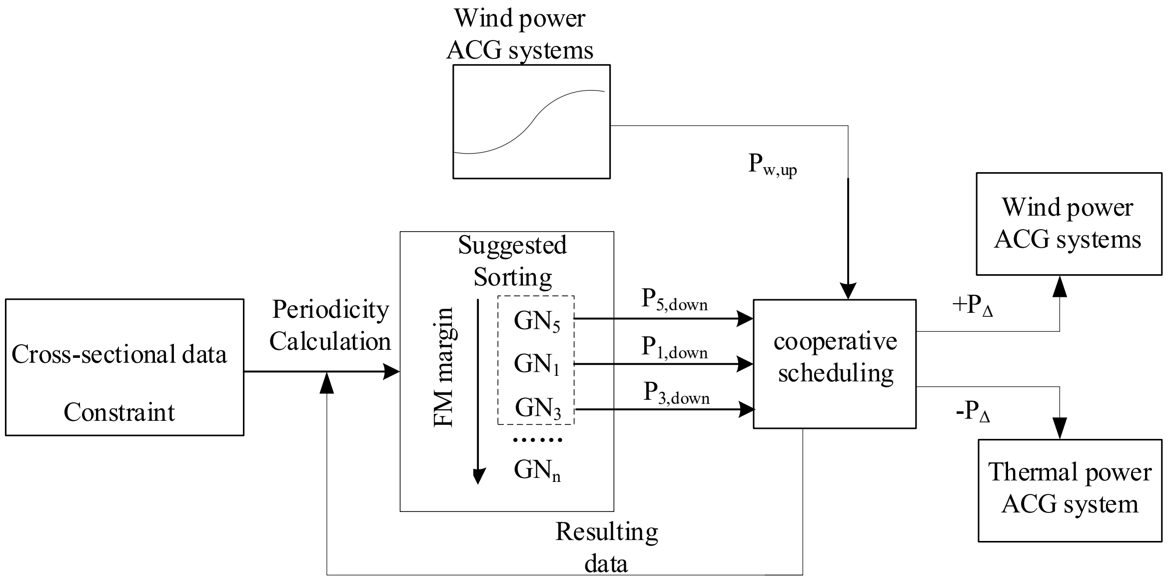

Fig.4 Iterative calculation process

GN1,GN3,GN5 are the recommended units for regulation

$p_{1,down}$, $p_{3,down}$, $p_{5,down}$ are the rate of electrical power regulation

GN1,GN3,GN5 original coordinate:
(265,206),(236.213),(201,186)

GN1,GN3,GN5 new coordinate:
(265,135),(236.139),(201,136)

In comparison, wind power consumption space has increased by 292 MW

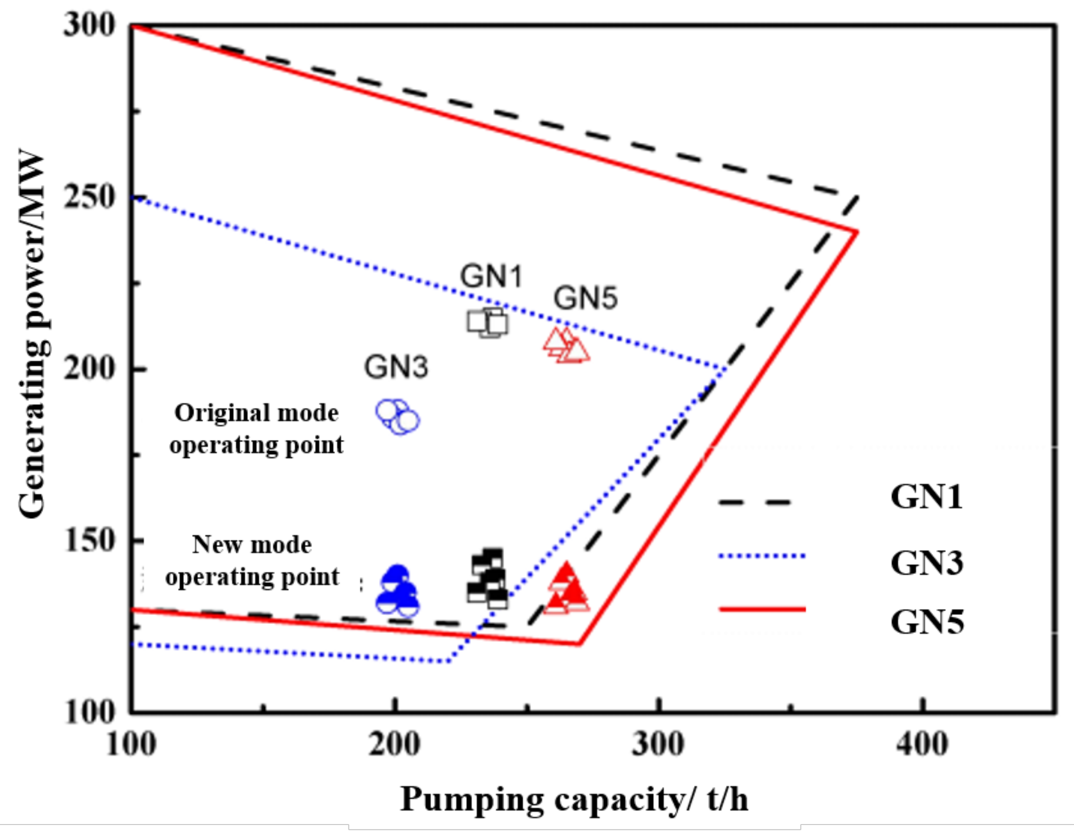

Fig.5 Operating point distribution of units under two modes

Examples of applications

- 10 units boosted the load distribution space by approximately 14.8%
- By the end of 2023, the installed capacity of cogeneration units within the grid's dispatch range will MW, adding a cumulative totalreach 13,210 of about 4 million MWh of clean energy generation space
- Enhances the utilization rate of high-efficiency units with large parameters and capacity, and reduces the overall grid energy consumption

Tab. 1 Summary of implementation effects of the new system

Unit	Old method/MWH	New method/MWH	Clean energy consumption improvement /MWH	Improvement ratio
GN1	130522	104869	25653	19.6%
GN2	131627	113610	18017	13.6%
GN3	92311	75489	16822	18.2%
GN4	127939	110484	17455	13.6%
GN5	124383	106328	18055	16.9%
GN6	90004	80699	9305	10.3%
GN7	88576	79891	8685	9.8%
GN8	86198	80052	6146	7.1%
GN9	152268	125651	26617	17.5%
GN10	153412	125577	27835	18.1%
Total	1177240	997050	174590	14.8%

Conclusion

- This paper establishes a scheduling support system for coordinated use of thermoelectricity, which collects and calculates thermoelectricity unit operation data in real time, and improves the flexibility of thermoelectricity units to participate in peak shifting and the power system regulation capability.
- The application effect of the system is verified, and the data show that the peaking capacity of the unit is improved under the premise of ensuring heat supply.

Reference

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