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Dynamic Environmental Economic and Collaborative Flexibility Dispatch of Integrated Power, Heating and Natural Gas Energy System

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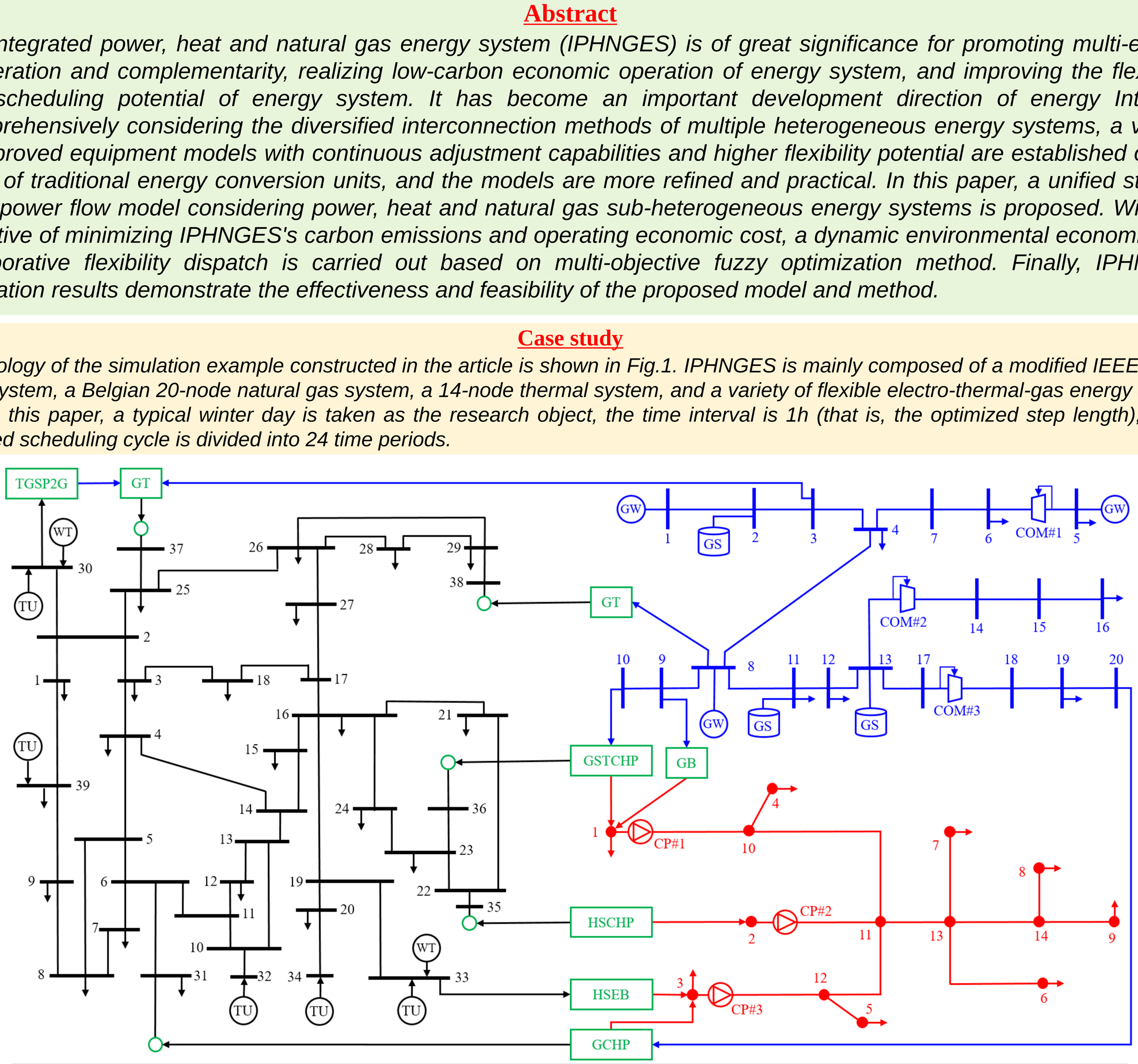
Abstract

The integrated power, heat and natural gas energy system (IPHNGES) is of great significance for promoting multi-energy cooperation and complementarity, realizing low-carbon economic operation of energy system, and improving the flexibility and scheduling potential of energy system. It has become an important development direction of energy Internet. Comprehensively considering the diversified interconnection methods of multiple heterogeneous energy systems, a variety of improved equipment models with continuous adjustment capabilities and higher flexibility potential are established on the basis of traditional energy conversion units, and the models are more refined and practical. In this paper, a unified steady-state power flow model considering power, heat and natural gas sub-heterogeneous energy systems is proposed. With the objective of minimizing IPHNGES's carbon emissions and operating economic cost, a dynamic environmental economic and collaborative flexibility dispatch is carried out based on multi-objective fuzzy optimization method. Finally, IPHNGES simulation results demonstrate the effectiveness and feasibility of the proposed model and method.

Case study

The topology of the simulation example constructed in the article is shown in Fig.1. IPHNGES is mainly composed of a modified IEEE39-node power system, a Belgian 20-node natural gas system, a 14-node thermal system, and a variety of flexible electro-thermal-gas energy coupling units. In this paper, a typical winter day is taken as the research object, the time interval is 1h (that is, the optimized step length), and an optimized scheduling cycle is divided into 24 time periods.



TGSP2G	Gas Storage Tank of Power To Gas	HSCHP	Heat Storage Combined Heat and Power	GCHP	Gas Combined Heat and Power	TU	Thermal Power	GW	Gas Wall	WT	Wind Turbine	TGS	Gas Storage Tank
HSEB	Heat Storage Electric Boiler	GSTCHP	Gas Solar Thermal CHP	CP	Circulating Pump	GT	Gas Turbine	GB	Gas Boiler	GS	Gas Storage	COM	Compressor

Fig.1 Simulation case of integrated power, heat and natural gas energy system

Conclusion

This paper takes IPHNGES as the research object, establishes a diversified flexible equipment model, and proposes a unified steady-state power flow model of IPHNGES. The results show that:

(a) Through coordinated dispatch of power, heat, and natural gas systems, the potential of multi energy coordination and complementary benefits can be brought into play, improve the economy, low-carbon and flexibility of interconnected systems, and improve the ability to optimize resource allocation.

(b) The interconnection of electric heating and gas systems provides more flexibility for operation scheduling. Fuzzy optimization realizes coordinated optimization scheduling that balances low-carbon and economic goals. Flexible coordinated scheduling reduces the intensity of mixed power flow fluctuations, especially for natural gas systems.

(c) Flexible coordinated scheduling can screen out devices with low continuous adjustment capabilities and low flexibility potential.

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