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Expansion Planning of Community-Scale Regional Integrated Energy System Considering Grid-Source Coordination: A Cooperative Game Approach

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ABSTRACT

Regional integrated energy system (RIES) has received extensive attentions, because of its excellent energy coupling and utilization capability. However, how to effectively and reasonably develop the expansion planning of RIES remains unsolved. Therefore, in this paper, a cooperative game based expansion planning model for community-scale RIES is proposed, considering both network structure and grid-source coordination. Firstly, the mathematical models of energy hub (EH) and system constraints, based on grid-source coordination, are established. A cooperative game based expansion planning model is then established and an iterative particle swarm optimization (IPSO) algorithm is introduced to solve the mixed-integer game model. Numerical case analysis shows that the cooperative game based expansion planning will not only increase the capacity of clean energy generation (e.g. CHP units), but also effectively reduce the alliance cost and system carbon emission.

Keywords: community-scale regional integrated energy system, expansion planning, grid-source coordination, cooperative game, iterative particle swarm optimization

NONMENCLATURE

Abbreviations	
CEP	Clean Energy Plant
CPP	Conventional Power Plant
EH	Energy Hub
GB	Gas Boiler
IPSO	Iterative Particle Swarm Optimization
RIES	Regional Integrated Energy System

1. INTRODUCTION

In the context of energy shortage and low energy utilization efficiency, integrated energy system has become a research focus in terms of expansion planning, optimized operation and demand management, etc. [1,2], due to its efficient complementary characteristics and high reliability of energy supply [3]. For the community-scale RIES, it is of great importance to coordinate the utilization of electricity, heat and natural gas, and rationally arrange energy production, transmission and consumption process in medium and long term horizon, so as to reduce costs and realize low-carbon environmental protection [4].

The expansion planning of community-scale RIES can be used to achieve an optimal configuration of the whole system under given energy development circumstances, so it has been widely studied. In [5], expansion planning of electricity, heat and transmission networks under security requirements was considered, and a complex nonlinear problem was converted into a MILP problem for global optimization. In [6], the mixed integer linear programming method for expansion planning of natural gas and power transmission system was studied. In [7], forms of extended planning to reduce carbon emission and cost in combined power and natural gas system were studied. In [8], an extension planning model of RIES which takes into account different time scales and uncertainties was established. In addition, considering that IES planning involves coordination and unification of multi-agent interests and multi-objective optimization, game theory related models also start to get noticed by researchers. In [9], the game behavior of each subject in an off-grid

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island was considered, and the configuration strategy of generators and energy storage devices on this basis was obtained. In [10], location, capacity and pricing of distributed power supply in distribution network based on the Stackelberg game were considered, and a new evolutionary algorithm was proposed to improve the game solving speed. In [11], an IES expansion planning model based on energy hub was proposed. In [12], a game theory view of power-gas joint planning with power and natural gas network as the game subject was put forward. In [13], planning of IES with Power to Gas (P2G) devices was considered, and the Nash equilibrium of independent participant's cost was realized by non-cooperative game.

However, despite above researches, the following problems remain unsolved in the study of expansion planning for community-scale RIES: 1) In order to reduce computational complexity, grid structure and power flow constraints are generally simplified or ignored, which cannot fully reflect the complementary characteristics of source side and grid side brought by multi-energy coupling, and few studies consider the existence of actual network loss; 2) Traditional community-scale RIES typically adopts global optimization for expansion planning and ignores the potential cooperation or competition between various subjects in the planning process, therefore cannot fully reflect the actual engineering practice.

To solve the above problems, the rest of this paper is organized as follows. Section 2 introduces the mathematical model of community-scale RIES with grid-source coordination, including energy hub model and system constraints. A cooperative game based expansion planning model is developed in Section 3, and an IPSO algorithm is introduced to effectively solve the proposed model. Section 4 provides the numerical studies to evaluate the efficiency and reliability of the proposed expansion planning game model and the selected IPSO algorithm by a comparison between the results of traditional global optimization and the cooperation game. Finally, Section 5 presents the conclusions.

2. MODELLING OF COMMUNITY-SCALE RIES WITH GRID-SOURCE COORDINATION

2.1 Energy hub model

Community-scale RIES can be seen as the integration of several microgrid-level RIES, in which each node can be regarded as an energy hub, and connected through natural gas network, power network and information network. An energy hub simplifies a complex multi-energy network into a two-port network [14], and converts the energy coupling characteristics and the energy balance constraints of the original network into matrix form.

For community-scale RIES studied in this paper, the input matrix includes electricity E_e and natural gas for CHP $E_{\mathrm{CHP,gas}}$ and GB $E_{\mathrm{GB,gas}}$, the output matrix includes the electrical load L_{E} and the thermal load L_{H}.

$$\begin{bmatrix} L_{\mathrm{E}} \\ L_{\mathrm{H}} \end{bmatrix} = \begin{bmatrix} \eta_{\mathrm{E}} & \eta_{\mathrm{CHP}}^{\mathrm{E}} & 0 \\ 0 & \eta_{\mathrm{CHP}}^{\mathrm{H}} & \eta_{\mathrm{GB}}^{\mathrm{H}} \end{bmatrix} \begin{bmatrix} E_e \\ E_{\mathrm{CHP,gas}} \\ E_{\mathrm{GB,gas}} \end{bmatrix} \tag{1}$$

where: η_{E} is the efficiency of transformer inside EH; $\eta_{\mathrm{CHP}}^{\mathrm{E}}$ is the gas-electric conversion efficiency; $\eta_{\mathrm{CHP}}^{\mathrm{H}}$ and $\eta_{\mathrm{GB}}^{\mathrm{H}}$ are the gas-thermal conversion efficiency of CHP and GB, respectively.

2.2 System planning and transmission constraints

Due to the existence of network configuration, modeling of community-scale RIES in this paper considers the network active power flow constraint, network loss constraint, natural gas pipeline constraint and constriction horizon constraint, etc., to fully present the grid-source coordination in actual engineering practice and to better reflect the complementary characteristics of the whole system. However, due to the page limit, some of the multi-energy balance constraints and generator output constraints (e.g. electricity balance constraint, CHP output limit, etc.) that having been taken into account during the optimization process have not been displayed.

1) Power Flow Constraint

In this paper, only active power constraint is considered, which can be expressed as:

$$P_{\mathrm{CPP}}^{i} + P_{\mathrm{CHP}}^{i} - P_{\mathrm{L}}^{i} = U_i \sum_{j=1}^{N} U_j \left(G_{ij} \cos\theta_{ij} + B_{ij} \sin\theta_{ij} \right) \tag{2}$$

where: P_{CPP}^{i}, P_{CHP}^{i} and P_{L}^{i} are conventional power plant (CPP) output, CHP unit power output and active load of node i, respectively; U_i, U_j are voltage of node i and node j, respectively; G_{ij}, B_{ij} and θ_{ij} are conductance, susceptance and phase difference between node i and j, respectively.

2) Total Network Loss Constraint

The same as power flow constraint, total network loss refers to active power loss in this paper.

$$P_{\text{loss}}^{\text{N}} - \sum_{i=1}^{N}\sum_{j\in i} G_{ij}\left(U_i^2 + U_j^2 - 2U_iU_j\cos\theta_{ij}\right) = 0 \quad (3)$$

3) Natural Gas Pipeline Constraint

$$\begin{cases} f_{ij}^{\ 2} = \phi_p\left(\pi_{ibt}^2 - \pi_{jbt}^2\right) sign\left(\pi_i, \pi_j\right) \\ f_{ij}^{\min} \le f_{ij} \le f_{ij}^{\max} \\ \pi_{ij}^{\min} \le \pi_{ij} \le \pi_{ij}^{\max} \end{cases} \quad (4)$$

where: f and π are the mass flow and the pressure of natural gas pipeline, respectively.

4) Transmission Line Constraint

$$P_l \le P_l^{\max} \quad (5)$$

where: $P_l^{\max}$ is the upper limit of transmission line.

5) Construction Horizon Constraint

$$\begin{cases} \kappa_G^{sg,T} = 0 \quad \forall sg \in SG \quad \forall T < T_{sg}^{\text{om}} \\ \kappa_{\text{G}}^{sg,\text{T-1}} \le \kappa_{\text{G}}^{sg,\text{T}} \quad \forall sg \in SG \quad \forall T \end{cases} \quad (6)$$

where: $\kappa_{\text{G}}^{sg,T}$ is 0-1 state variable of candidate generator; SG is the candidate generator set; T_{sg}^{om} is commission year for candidate generator at node sg.

$$\begin{cases} \theta_{\text{L}}^{k,T} = 0 \quad \forall k \in K \quad \forall T < T_k^{\text{om}} \\ \theta_{\text{L}}^{k,T-1} \le \theta_{\text{L}}^{k,T} \quad \forall k \in K \quad \forall T \end{cases} \quad (7)$$

where: $\theta_{\text{L}}^{k,T}$ is 0-1 state variable of candidate line; K is the candidate line set; T_k^{om} is the commission year for k_{th} candidate line.

3. CALCULATION OF EXPANSION PLANNING BASED ON COOPERATIVE GAME

The traditional community-scale RIES generally considers a global optimization problem for system planning, and further transforms this complex MINP problem into a LP problem for solution. However, with the increase of clean energy plant (CEP) construction, the competition and cooperation among various stakeholders have become increasingly obvious, the existence of cooperative game among the stakeholders should be considered. That is, CPP and CEP (mostly consists of CHP units) can form alliance through valid contracts, and then game with the grid side, so as to maximize the self-interests under the view of grid-source coordination.

3.1 Formation of the cooperative game

1) Game Participants

The cooperative game based expansion planning model proposed in this paper includes two game participants, namely CPP & CHP alliance and the grid.

2) Strategy Sets

The game participants' strategy can be formed as $\left(f_{\text{GC}}, f_{\text{N}}\right)$, in which the alliance strategy is the status and the installed capacity of the new generators (i.e. $f_{\text{GC}}\left(\kappa_{\text{GC}}, P_{\text{GC}}\right) = \left\{\kappa_{\text{CPP}}^1, \cdots \kappa_{\text{CPP}}^{\Phi_{\text{CPP}}}, P_{\text{CPP}}^1, \cdots P_{\text{CPP}}^{\Phi_{\text{CPP}}}; \kappa_{\text{CHP}}^1, \cdots \kappa_{\text{CHP}}^{\Phi_{\text{CHP}}}, P_{\text{CHP}}^1, \cdots P_{\text{CHP}}^{\Phi_{\text{CHP}}}\right\}$), and the grid side strategy is the status of new transmission lines (i.e. $f_{\text{N}}\left(\theta_{\text{L}}\right) = \left\{\theta_{\text{L}}^1, \cdots, \theta_{\text{L}}^K\right\}$).

3) Multi-Player Cost Model

The expansion planning in this paper assumes the community-scale RIES can be self-sufficient without purchasing energy from other entities, so the costs of source side (i.e. CPP and CHP unit) and grid side are chosen as the objective functions.

For the source side, costs of both CPP and CHP unit include investment cost and generation cost.

$$\begin{aligned} C_{\text{CPP}} &= \sum_{t=1}^{T}(C_{\text{CPPinv}}^t + C_{\text{CPPF}}^t) \\ &= \sum_{t=1}^{T}\left(\left(\sum_{c=1}^{\Phi_{\text{CPP}}} \kappa_{\text{CPP}}^c P_{\text{CPP}}^c\right)\frac{r^t(1+r^t)^{L_{\text{CPP}}}}{(1+r^t)^{L_{\text{CPP}}}-1} + \sum_{h=1}^{H}\sum_{c=1}^{\Phi_{\text{CPP}}} w_{\text{cppf}}\, p_{\text{CPP}}^c(h)\right) \end{aligned} \quad (8)$$

$$\begin{aligned} C_{\text{CHP}} &= \sum_{t=1}^{T}(C_{\text{CHPinv}}^t + C_{\text{CHPF}}^t) \\ &= \sum_{t=1}^{T}\left(\left(\sum_{c=1}^{\Phi_{\text{CHP}}} \kappa_{\text{CHP}}^c P_{\text{CHP}}^c\right)\frac{r^t(1+r^t)^{L_{\text{CHP}}}}{(1+r^t)^{L_{\text{CHP}}}-1} + \sum_{h=1}^{H}\sum_{c=1}^{\Phi_{\text{CHP}}} w_{\text{chpf}}\frac{P_{\text{CHP}}^c(h)}{\eta_{\text{CHP}} Z_{\text{gas}}}\right) \end{aligned} \quad (9)$$

where: r is the discount rate; L_{CPP} and L_{CHP} is the service life of CPP and CHP unit, respectively; w_{cppf} is the generation cost of CPP in p.u.; w_{chpf} is the price of natural gas; Z_{gas} is the calorific value of natural gas.

Therefore, the CPP & CHP alliance cost can be calculated as $C_{\text{GC}} = C_{CPP} + C_{CHP}$.

For the grid side, the cost includes transmission line investment cost and network loss cost.

$$\begin{aligned} C_{\text{N}} &= \sum_{t=1}^{T}(C_{\text{Ninv}}^t + C_{\text{Nloss}}^t) \\ &= \sum_{t=1}^{T}\left(\left(\sum_{k=1}^{K}\theta_{\text{L}}^{k,t}\varphi_{\text{L}} L_k\right)\frac{r^t(1+r^t)^{L_{\text{N}}}}{(1+r^t)^{L_{\text{N}}}-1} + \sum_{h=1}^{H} k_{\text{N}} P_{\text{loss}}^{\text{N}}(h)\right) \end{aligned} \quad (10)$$

where: φ_{L} is the transmission line construction cost in p.u.; L_k is the length of k_{th} line; L_{N} is the service life; k_{N} is the network loss coefficient.

It should be noted that the network loss in grid side is reflected as part of the generation cost in source side, which embodies the significance of grid-source coordination.

4) Game Equilibrium

Since there is at least one game equilibrium for any finite strategy game [15], and the alliance strategy f_{GC}

as well as the grid side strategy f_N in this paper are both finite strategy sets limited by installation location and time, there must be an equilibrium solution for the above cooperative game, which can be expressed as:

$$(f_{\mathrm{GC}}^*, f_{\mathrm{N}}^*)\begin{cases} C_{\mathrm{GC}}^* = \arg\min\left(f_{\mathrm{GC}}, f_{\mathrm{N}}^*\right) \\ C_{\mathrm{N}}^* = \arg\min\left(f_{\mathrm{GC}}^*, f_{\mathrm{N}}\right) \end{cases} \tag{11}$$

3.2 IPSO algorithm for cooperative game

Science the cooperative game developed in 3.1 is a complex MINP problem, an iterative algorithm based on particle swarm optimization is adopted to solve it. During each iteration, all players share information and adjust their own strategies. The flowchart of IPSO is shown in Figure 1, where green represents the gird-source cooperative game process. Brief descriptions of the steps are as follows:

Step 1: Input basic parameters within the expansion planning horizon.

Step 2: Construct a strategic game model. According to Section 2 and 3.1, establish the cooperative game based expansion planning model for community-scale RIES, considering grid-source coordination.

Step 3: Generate the initial strategies. Randomly select the initial strategies from the candidate CPP, CHP units and transmission lines.

Step 4: Each participant makes its optimal decision independently based on PSO algorithm, and realize expansion planning through information sharing as well as multiple iteration. If the costs of both source side and grid side are stable, i.e. $\left(f_{\mathrm{GC}}^n, f_{\mathrm{N}}^n\right) = \left(f_{\mathrm{GC}}^{n-1}, f_{\mathrm{N}}^{n-1}\right)$, then considers that the game equilibrium has been reached.

Step 5: Output the equilibrium solution, i.e. the final planning scheme under cooperative game $\left(f_{\mathrm{GC}}^*, f_{\mathrm{N}}^*\right)$.

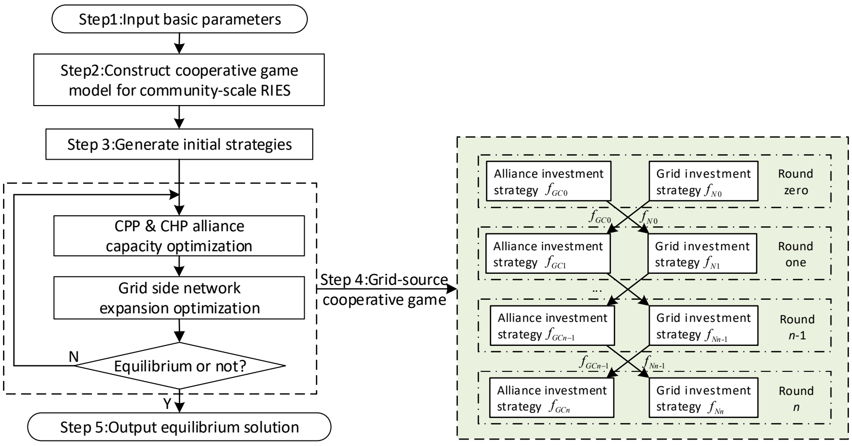

Fig. 1. Flowchart of IPSO algorithm for cooperative game

4. CASE STUDIES

4.1 Test system description

The six-node test system, which consists electricity, natural gas and heat, used as a numerical case is illustrated in Figure 2, where each node is seen as an energy hub. The original system parameters of this community-scale RIES are given in [11], and the parameters of the candidate components are presented in Table 1. This case study is applied to a fifteen-year expansion planning horizon and the costs are analyzed on an annual basis, i.e., each candidate generator or transmission line is considered for installation at the beginning of a year [11]. It should be noted that $k_{\mathrm{N}} = 500\,\$/\mathrm{MWh}$ and $r = 15\%$ are fixed, and the annual system electrical load and thermal load growth rate are 7% and 5% respectively. Also, assuming all the heat productions are for local consumption only and no restrictions on annual investments or the number of components that can be installed in one year are set.

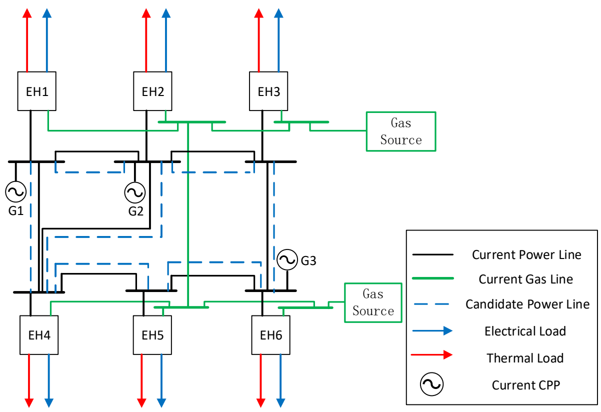

Fig. 2. Schematic diagram of six-node community-scale RIES

Table 1 Parameters of candidate generators and lines

Line From	Line To	Capacity (MW)	Resistance (Ω)	Comm. Year	CPP No.	CPP Bus	Capacity (MW)	Comm. Year	CHP No.	CHP Bus	Capacity (MW)	Comm. Year
1	2	15	0.170	5	1	1	8	3	1	1	16	2
2	3	10	0.037	2	2	2	10	4	2	2	12	3
1	4	10	0.258	4	3	3	6	6	3	4	12	2
2	4	10	0.197	6	4	4	8	5	4	5	10	4
4	5	10	0.037	5	5	5	10	6				
5	6	10	0.140	3	6	6	8	8				
3	6	10	0.018	2								

4.2 Expansion planning results comparison

Two cases are used to illustrate the effectiveness of the cooperative game based expansion planning for the community-scale RIES.

Case 1 considers a global optimization model aiming at obtaining the lowest cost of the whole system. At the end of the planning horizon, 18 MW of CPP capacity and 22 MW of CHP capacity at bus 4, bus 5 and bus 6, together with 1 transmission line from bus 2 to bus 3, are installed to meet the expected load growth. For source side, two CPPs are installed at node 4 and 5 and two CHP units are installed at node 5 and 6. For grid side, one transmission line between node 2 and 3 is constructed.

Case 2 is a cooperative game expansion planning model with source side (i.e. CHP & CPP alliance) and grid side coordination. In this case, because of the electricity supply from the CHP units, no CPP is installed. For source side, 34 MW of CHP units are installed at bus 2, bus 4 and bus 5. For grid side, the same transmission line between node 2 and 3 is constructed.

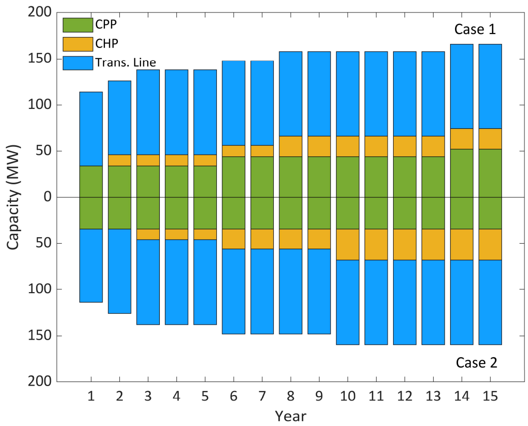

Fig. 3. Expansion planning results for case 1 and case 2

The overall expansion planning results are shown in Figure 3. It can be seen that, by considering the cooperative game model, CPP installation at node 6 in the 14th year is cancelled, and the installation of a new CHP unit on node 4 is delayed from year 2 to year 3. Besides, two CHP units will be added in year 6 and year 10 at node 5 and 2, respectively, to supply both the electrical and thermal load growth at the same time. Meanwhile, the construction time of new transmission line between node 2 and node 3 is advanced from year 3 to year 2.

4.3 Economic optimization results comparison

Comparison of costs of the two cases is shown in Table 2. During the 15-year planning horizon, the cost of CPP and CHP unit is reduced by $2.24 million each by considering the cooperative game. Fundamentally, the cost saving for the source side in case 2 is caused by both the cooperation between generators inside source side and the coordination between source side and grid side, which indicates that the formation of the alliance and the consideration of grid-source coordination brings better benefits. Plus, DP index under the above allocation is 0.5, which means the source side alliance is stable.

Table 2 Comparison of source side and grid side cost

	Source side (Million)			Grid side	Total
	CPP	CHP unit	Total	(Million)	(Million)
Case 1	$404.95	$115.74	$**520.69**	$16.55	$537.24
Case 2	$402.71	$113.50	$**516.20**	$21.37	$537.57

Although the total cost of the whole system is slightly ascended by $0.33 million, the global optimization in case 1 sacrifice the revenue on the source side. On one hand, this does not accord with the actual engineering practice; on the other hand, forcing this kind of optimized strategy may reduce the vitality of the integrated energy system. Therefore, the cooperative strategy proposed in case 2 is more practical.

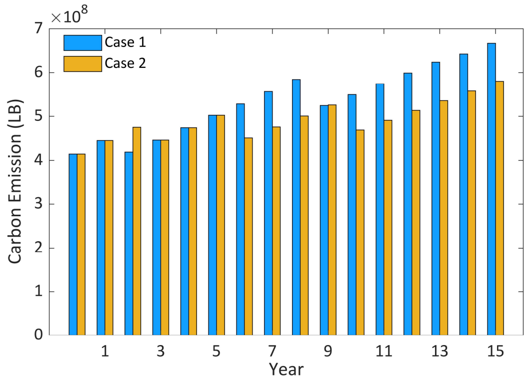

Fig. 4. Copmarison of carbon emission

Moreover, by considering the cooperative game model, carbon emission of case 2 is reduced by 8.5% (shown in Figure 4), because CHP combusted less fuel than equivalent CPP and GB to produce the same amount of electricity and heat.

5. CONCLUSION AND PROSPECT

A cooperative game based expansion planning model of community-scale RIES considering grid-source coordination is proposed in this paper. The main contributions are: 1) System models considering network structure and grid-source coordination are established; 2) An iterative particle swarm optimization algorithm is applied to effectively solve the mixed-integer cooperative game, and a comparison with the global optimization result is conducted; 3) Case analysis demonstrates that the proposed game model can reduce cooperators' cost and reduce the carbon emission. 4) Cooperative game based community-scale RIES expansion planning under grid-source coordination can better reflect the rational behavior of individuals and the interest needs of each participant, while providing more choices for community-scale RIES planning.

Future researches may include district heating and natural gas networks into expansion planning scheme and introduce more candidate energy coupling components for expansion planning as well.

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REFERENCE

[1] L. Yang, D. Wang, H. Jia, et al. Multi-objective stochastic expansion planning based on multi-dimensional correlation scenario generation method for regional integrated energy system integrated renewable energy[J]. Applied Energy 2020; 276:115395.

[2] L. Wang, W. Gu, Z. Wu, et al. Non-cooperative game-based multilateral contract transactions in power heating integrated systems [J]. Applied Energy 2020; 268:114930.

[3] Z. Chen, J. Liu, X. Liu. GPU accelerated power flow calculation of integrated electricity and heat system with component-oriented modeling of district heating network[J]. Applied Energy 2021.

[4] J. Liu, Y. Chen, C. Duan, et al. Distributionally Robust Optimal Reactive Power Dispatch with Wasserstein Distance in Distribution Network[J]. Journal of Modern Power Systems and Clean Energy 2020; 8(3): 426-436.

[5] H. Fathtaba, T. Barforoushi, M. Shahabi. Dynamic long-term expansion planning of generation resources and electric transmission network in multi-carrier energy systems[J]. Electrical Power and Energy Systems 2018; 102:97-109.

[6] Y. Zhang, Y. Hu, J. Ma, et al. A mixed-Integer linear programming approach to security constrained co-optimization expansion planning of natural gas and electricity transmission systems[J]. IEEE Transactions on Power Systems 2018; 33(6):6368-6378.

[7] Q. Jing, Y. Zhao, J. Zhao, et al. Low carbon oriented expansion planning of integrated gas and power systems[J]. IEEE Transactions on Power Systems 2015; 30(2):1035-1046.

[8] Q. Wang, C. Wang, N. Xie, et al. A hybrid CVaR-IGDT expansion planning model for regional integrated energy system[J]. Power System Technology 2020; 2:505-515.

[9] X. Guo, T. Wen, X.Lin, et al Integration capacity optimization of multi-stakeholder generation-storage on large-scale off-grid island[J]. Proceeding of the CSEE 2019; 39: 1-14.

[10] MH. Moradi, M. Abedini, SM. Hosseinian. A combination of evolutionary algorithm and game theory for optimal location and operation of DG from DG owner standpoints[J]. IEEE Transactions on Smart Grid 2016; 7(2):608-616.

[11] X. Zhang, S. Mohammad, A. Ahmed, et al. Optimal expansion planning of energy hub with multiple energy infrastructures[J]. IEEE Transactions on Smart Grid 2015; 6(5):2302-2311.

[12] N. Yang, Y. Huang, B. Dong, et al. Research on the joint planning method of electricity-gas integrated energy system based on multi-agent game[J]. Proceeding of the CSEE 2019; 39(22): 6521-6532.

[13] X. Zhang, K. Chan, H. Wang, et al. Game-theoretic planning for integrated energy system with independent participants considering ancillary services of power-to-gas stations[J]. Energy 2019; 176:249-264.

[14] H. Cheng, X. Hu, L. Wang, et al. Review on research of regional integrated energy system planning[J]. Automation of Electric Power Systems 2019; 43(7):2-13

[15] X. Xu, J. Li, Y. Xu, et al. A two-stage game-theoretic method for residential PV panels planning considering energy sharing mechanism[J]. IEEE Transactions on Power Systems 2020; 35(5): 3562-3573.

