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Evaluation and Improvement of the Comprehensive Cost-Benefit of Investment and Operation of New Energy Heating System

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ABSTRACT

The on-spot consumption scheme of new energy can improve the utilization efficiency of energy and provide references for the transformation from the conventional regional coal heating mode to the more efficient electric heating mode. To figure out the economic benefit brought by the new energy heating mode, it's necessary to evaluate its cost-benefit and construct reasonable model to study the dynamic market response. Therefore, this paper aims to evaluate the comprehensive cost benefit of the investment and operation of new energy heating (NEH) system and find ways to improve the said cost benefit. At first, this paper built an investment and operation model for the said NEH system, and constructed an objective function with the minimization of new energy disuse rate as the objective in the commissioned operation scheme for new energy on-spot consumption system connected with large electric heating boiler and large-capacity heat accumulator. Then, the paper gave the structure of the NEH system, and analyzed the main participants, investment and operation modes, and economic benefit of the NEH system. At last, corresponding experimental results and analysis results of an example case were given, which had verified the effectiveness of the proposed model.

1. INTRODUCTION

A good way to achieve environmental protection and sustainable development is to find alternative clean energy source and use the new energy to replace conventional heating mode that consumes fossil fuels [1-7]. In regions of Northwest, North, and Northeast China, the heat load of heating system during winter heating seasons is huge [8-11]. The new energy on-spot consumption scheme that integrates heat accumulators, electric boilers and other electric-heat conversion equipment, and the Combined Cooling Heating and Power (CCHP) units can improve the utilization efficiency of new energy [12-17]. The new scheme can effectively decrease the consumption of fossil fuels, reduce the loss of power transmission, gain benefit for renewable energy power generation company, enhance the grid's ability to accept new energy, and provide useful reference for the transformation from the conventional regional coal heating mode to the more efficient electric heating mode.

In the framework of decarbonization of the building industry, Aste et al. [18] introduced the case of a new near-zero energy zone located in the urban area of Milan (Italy); after evaluating the energy demand of the region, a low-temperature small-sized wood-made biomass thermal power plant was designed for the region, which integrated the plant with groundwater heat pumps and solar photovoltaic systems, the design of the multi-energy system can basically cover the energy demand of the almost completely-renewable city. Yu and Geng [19] constructed a CCHP system driven by distributed energy source for the commissioned operation of distributed energy utilization, which includes three subsystems: the power subsystem, the combined cooling and heating subsystem, and the ground source heat pump subsystem; then, taking CCHP system driven by natural gas as the reference frame, the paper proposed three indicators (energy, economy, and environment performance), three load modes (heat load mode, electric load mode, and heat-electric hybrid mode), and three system operation modes (the commissioned operation energy efficiency, total operating cost, and CO2 emission reduction). Considering that Korea's renewable energy share is only 4%, and the centralized renewable hybrid regional heating and cooling demonstration complex could be a new alternative for the promotion of new and renewable energy sources, Heo et al. [20] introduced a newly-built centralized renewable hybrid regional heating and cooling demonstration complex, and briefly described the load estimation method, the installed capacity of the new energy and renewable energy equipment, and the controlling strategy under the operation mode. Siddiqui and Dincer [21] developed a novel system that can produce clean electricity, heat, hydrogen, and ammonia at the same time based on wind and solar energy; air and water were considered as two inputs for producing clean hydrogen and synthesizing into ammonia; with the help of excess wind power, in the proposed system, hydrogen and ammonia could be further synthesized, and the output ammonia could be used as an energy storage medium; besides, when the energy availability is relatively low, the excess solar energy could be stored and used to generate electricity as well as dissociate ammonia for fuel cell operation. Using renewable energy to produce energy is one of the main priorities in the energy policy of European Union, Grigoniene et al. [22] analyzed the regional solar energy heating system in several EU countries in detail and summarized the main results, in addition, the paper also evaluated the principles of sustainable deign and the application of advanced regional solar energy heating system in Lithuania, and discussed its feasibility.

World field scholars have conducted in-depth discussion on the problem of new energy consumption lag, hoping to solve this problem by building suitable consumption modes. The existing mathematical models for NEH system are generally not comprehensive enough, the limited control variables are a common defect in them. NEH has obvious advantages in terms of energy saving and emission reduction, inevitably, it'll receive the support for both government and the public. To figure out the economic benefit brought by on-spot NEH system, it's necessary to evaluate its cost-benefit and construct reasonable model to study the dynamic market response. Therefore, this paper aims to evaluate the comprehensive cost benefit of the investment and operation modes of NEH system and find ways to improve the said cost benefit. In the second chapter, this paper built an investment and operation model for NEH system, and constructed an objective function with the minimization of new energy disuse rate as the objective in the commissioned operation scheme for on-spot NEH system connected with large electric heating boiler and large-capacity heat accumulator. The third chapter gave the structure of NEH system, and analyzed its main participants, investment and operation modes, and economic benefit. The fourth chapter gave experimental results and analysis results of an example case, and verified the effectiveness of the proposed model.

2. THE INVESTMENT AND OPERATION MODEL FOR NEH SYSTEM

To reduce the heating pressure during winter seasons and deliver head load to users with higher new energy utilization rate, this paper constructed an objective function with the minimization of new energy disuse rate as the objective in the commissioned operation scheme for on-spot NEH system connected with large electric heating boiler and large-capacity heat accumulator. Assuming: Φ represents one cycle of the commissioned operation; $T_{nt}(o)$ represents the predicted output of new energy at time moment o; $T_{st}(o)$ represents the actual output of new energy at time moment o, then there is:

$$min\sum_{o=1}^{\Phi}\left(T_{mt}\left(o\right)-T_{st}\left(o\right)\right) \tag{1}$$

Assuming: $T_{qt}(o)$ represents the predicted power of wind power generation at time moment o; $T_{rt}(o)$ represents the predicted power of photovoltaic power generation at time moment o; the power of wind power generation and the power of photovoltaic power generation together constitute the total power of the new energy power generation, that is:

$$T_{mt}\left(o\right)=T_{qt}\left(o\right)+T_{rt}\left(o\right) \tag{2}$$

For a power system, regardless of the voltage level, the balance between generated power, transmission power, and distribution power is maintained all the time, so in the consumption model of the NEH system, the balance between generated power, heat load, and regular electricity load of different type power systems should be maintained as well. Assuming: m represents the number of thermal power generating units; $T_{g,i}(o)$ represents the generated power of the i-th thermal power generating unit at time moment o; $T_K(o)$ represents the power of regular electricity load at time moment o; n represents the number of electric boilers; $T_{dy,j}(o)$ represents the power of the i-th electric boiler at time moment o, then there is:

$$\sum_{i=1}^{m}T_{g,i}\left(o\right)+T_{st}\left(o\right)=T_{K}\left(o\right)+\sum_{j=1}^{n}T_{dy,j}\left(o\right) \tag{3}$$

Assuming: ξ represents the electricity conversion efficiency coefficient of the electric boiler; $T_{ha}(o)$ represents the power of heat accumulator at time moment o; $T_{hn}(o)$ represents the required heating power at time moment o; then Formula 4 gives the constraint for the balance relationship that the electric heating load needs to meet:

$$\sum_{j=1}^{n}T_{dy,j}\left(o\right)*\xi+T_{ha}\left(o\right)=T_{hn}\left(o\right) \tag{4}$$

Assuming: T_g^- and T_g^+ represent the minimum output power and maximum output power of the thermal power generating units, then Formula 5 gives the constraint for the operation of conventional thermal power generating units:

$$T_{g}^{-}\leq T_{g,i}\left(o\right)\leq T_{g}^{+} \tag{5}$$

Assuming: T_i^- and T_i^+ represent the power decrease limit and power increase limit of conventional thermal power generating units, then Formula 6 gives the constraint for the ramping power of conventional thermal power generating units:

$$\begin{aligned}T_{g,i}\left(o\right)-T_{g,i}\left(o-1\right)\leq T_{i}^{-}\\T_{g,i}\left(o-1\right)-T_{g,i}\left(o\right)\leq T_{i}^{+}\end{aligned} \tag{6}$$

Formula 7 gives the constraint for the operation of electric boiler:

$$0\leq T_{de,j}\left(o\right)\leq T_{dy}^{+} \tag{7}$$

Formula 8 gives the constraint for the operation of heat accumulator:

$$R_{ha}^{-}\leq R_{ha}\left(o\right)\leq R_{ha}^{+} \tag{8}$$

$$T_{ha}^{-}\leq\left|R_{ha}\left(o\right)-R_{ha}\left(o-1\right)\right|\leq T_{ha}^{+} \tag{9}$$

Formula 9 gives the constraint for the new energy power generation:

$$0\leq T_{st}\left(o\right)\leq T_{qt}\left(o\right)+T_{rt}\left(o\right) \tag{10}$$

Assuming: $BAT_{CS}(o+1)$ and $BAT_{CS}(o)$ respectively represent the State of Charge (SOC) of the battery at time moment $o+k$ and time moment o; BAT_Z represents the battery capacity; BAT_{T-C} and BAT_{T-D} represent the charging power and discharging power of the battery; ζ_C and ζ_D represent charging efficiency and discharging efficiency of the battery; then, during the charging and discharging process, the constraints that the SOC of the battery needs to meet are:

$$\begin{cases} BAT_{CS}(o+1) = BAT_{CS}(o) + \zeta_C BAT_{T-C}(o) / BAT_Z \\ BAT_{CS}(o+1) = BAT_{CS}(o) - BAT_{T-D}(o) / \zeta_D BAT_Z \end{cases} \tag{11}$$

3. EVALUATION OF THE COMPREHENSIVE COST-BENEFIT OF NEH SYSTEM

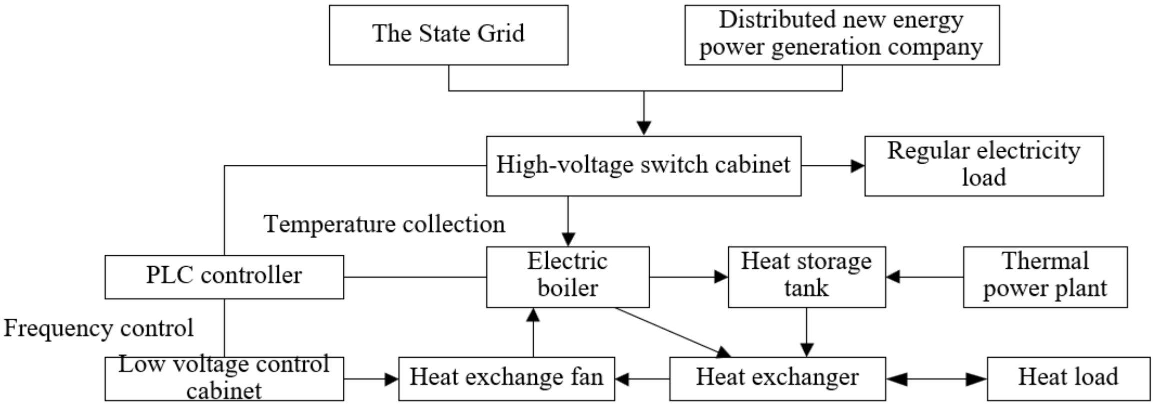

Figure 1. Structure of the NEH system

The total cost of a NEH system is consisted of two parts: the initial investment cost, and the system operation cost. The initial investment cost is the one-time investment spent on building the NEH system in the first place, and the system operation cost contains the various expenditures spent on system maintenance and daily operation after the NEH system has been put into actual production and operation, specifically, it includes the costs of production materials and staff wages, etc. Figure 1 gives the structure of the NEH system. As can be seen from the figure, main participants in the NEH system include: thermal power plant or regional boiler room, distributed new energy power generation company, and energy companies such as the State Grid. Centered on these participants, this paper analyzed the investment and operation modes of the NEH system and discussed its economic benefit.

For main participants in the NEH system, under the independent investment and independent operation mode, a single energy supply company independently bears all the investment and operation costs of the NEH system, and attains all benefits of the NEH system. Assuming: Z_x represents the total investment cost of the NEH system; Z_{ix} represents the investment cost of the i-th NEH subsystem; Z_y represents the operation cost of the NEH system; $Z_{iy,o}$ represents the operation cost of the i-th NEH subsystem in the o-th year; N represents the life cycle of the NEH system; M represents the number of NEH subsystems, then the total cost of the energy supply company could be calculated as below:

$$Z = Z_x + Z_y \tag{12}$$

$$Z_x = \sum_{i=1}^{m} Z_{ix} \tag{13}$$

$$Z_y = \sum_{i=1}^{m} \sum_{o=1}^{n} Z_{iy,o} \tag{14}$$

Assuming: IGE represents the total benefit of the energy supply company; $GE_{i,o}$ represents the benefit of the i-th NEH subsystem in the o-th year, then, the total benefit of the energy supply company could be calculated by the following formula:

$$GE = \sum_{i=1}^{m} \sum_{t=1}^{n} GE_{i,t} \tag{15}$$

For main participants in the NEH system, under the independent investment and commissioned operation mode, a single energy supply company independently bears all the investment cost, and a third-party operating unit is entrusted by the energy supply company to assume the job of operating the NEH system, the energy supply company and the third-party operating unit share the operating benefit of the NEH system according to an agreed proportion. The total cost of the energy supply company is the investment cost of the NEH system. Assuming: Z_x represents the total investment cost of the energy supply company; Z_{ix} represents the investment cost of the i-th NEH subsystem, then there are:

$$Z = Z_x \tag{16}$$

$$Z_x = \sum_{i=1}^{m} Z_{ix} \tag{17}$$

Assuming: GE represents the total operating benefit of the NEH system; $GE_{i.o}$ and $Z_{iy,o}$ respectively represent the benefit and operating cost of the i-th NEH subsystem in the o-th year; l represents the operating benefit share ratio of the energy supply company and third-party operating unit; then, under this mode, the total operating benefit of the NEH system can be calculated by the following formula:

$$GE = \sum_{o=1}^{n} \left(\sum_{i=1}^{m} GE_{i,o} - \sum_{i=1}^{m} Z_{iy,o} \right) * l \tag{18}$$

For main participants in the NEH system, under the cooperative investment and cooperative operation mode, multiple energy supply companies jointly undertake the responsibilities of investment and operation of the NEH system and share the operating benefit. The cooperation mode can be divided into two types: agreed system investment module, and the agreed system investment ratio.

In case of the first type (agreed system investment module), assuming: Z_j represents the total cost of the j-th energy supply company; Z_{jx} represents the system construction cost invested by the j-th energy supply company; Z_{jix} represents the construction cost invested by the j-th energy supply company in the construction of the i-th NEH subsystem; Z_{jy} represents the total operating cost of the j-th energy supply company; Z_{jiy} represents the operating cost of the i-th NEH subsystem invested by the j-th energy supply company in the o-th year, then, under this mode, the total cost of each energy supply company is:

$$Z_j = Z_{jx} + Z_{jy} \tag{19}$$

$$Z_{jx} = \sum_{i=1}^{m} Z_{jix} \tag{20}$$

$$Z_{jy} = \sum_{i=1}^{m} \sum_{o=1}^{n} Z_{jiy,o} \tag{21}$$

Assuming: GE_j represents the total benefit of the j-th energy supply company; $GE_{ji,o}$ represents the benefit of the i-th NEH subsystem attained by the j-th energy supply company in the o-th year, then, the total benefit of each energy supply company can be calculated by the following formula:

$$GE_j = \sum_{i=1}^{m} \sum_{o=1}^{n} GE_{ji,o} \tag{22}$$

In case of the second type (agreed system investment ratio), assuming: Z_j represents the total cost of the j-th energy supply company; Z_x represents the total investment cost of the NEH system; Z_{ix} represents the investment cost of the i-th NEH subsystem; Z_y represents the operating cost of the NEH system; $Z_{iy,o}$ represents the operating cost of the i-th NEH subsystem in the o-th year; l_j represents investment proportion of the j-th energy supply company, then, the total cost of each energy supply company is:

$$Z_j = \left(Z_x + Z_y\right) * l_j \tag{23}$$

$$Z_x = \sum_{i=1}^{m} Z_{ix} \tag{24}$$

$$Z_y = \sum_{i=1}^{m} \sum_{o=1}^{n} Z_{iy,o} \tag{25}$$

Assuming: GE_j represents the total benefit of the j-th energy supply company; $GE_{i,o}$ represents the benefit of the i-th NEH subsystem in the o-th year; l_j represents the investment proportion of the j-th energy supply company, then, in this case, the total benefit of each energy supply company is:

$$GE_j = \sum_{i=1}^{m} \sum_{o=1}^{n} GE_{ji,o} * l_j \tag{26}$$

For main participants in the NEH system, under the cooperative investment and commissioned operation mode, multiple energy supply companies jointly invest in the construction of the NEH system, and a third-party operating unit is entrusted by the energy supply companies to assume the job of operating the NEH system, and all energy supply companies and the third-party operating unit share the operating benefit of the NEH system according to the agreed proportion. The cooperation mode in the investment stage also can be divided into two types: the agreed system investment module, and the agreed system investment ratio.

In case of the first type (agreed system investment module), assuming: Z_j represents the total cost of the j-th energy supply company; Z_{jx} represents the total investment cost of the NEH system invested by the j-th energy supply company; Z_{jix} represents the investment cost of the i-th NEH subsystem invested by the j-th energy supply company, then, in this case, the total cost of each energy supply company is:

$$Z_j = Z_{jx} \tag{27}$$

$$Z_{jx} = \sum_{i=1}^{m} Z_{jix} \tag{28}$$

Assuming: GE_j represents the benefit of the j-th energy supply company; $GE_{ji,o}$ and $Z_{jiy,o}$ respectively represent the benefit and operating cost of the i-th NEH subsystem invested by the j-th energy supply company in the o-th year; l represents the operating benefit share ratio of each energy supply company and the third-party operating unit, then, in this case, the total benefit of each energy supply company is:

$$GE_j = \sum_{t=1}^{n} \left(\sum_{i=1}^{m} GE_{ji,o} - \sum_{i=1}^{m} Z_{jiy,o} \right) * l \tag{29}$$

In case of the second type (agreed system investment ratio), assuming: Z_j represents the total cost of the j-th energy supply company; Z_x represents the total investment cost of the NEH system; Z_{ix} represents the investment cost of the i-th NEH subsystem; l_j represents the investment proportion of the j-th energy supply company, then, in this case, the total cost of each energy supply company is:

$$Z_j = Z_x * l_j \tag{30}$$

$$Z_x = \sum_{i=1}^{m} Z_{ix} \tag{31}$$

Assuming: GE_j represents the total benefit of the j-th energy supply company; l_j represents the investment proportion of the j-th energy supply company; $GE_{i,o}$ represents the benefit of the i-th NEH subsystem in the o-th year; $Z_{iy,o}$ represents the operating cost of the i-th NEH subsystem in the o-th year, then, in this case, the total benefit of each energy supply company is:

$$GE_j = GE * l_j \tag{32}$$

$$GE = \sum_{o=1}^{n} \left(\sum_{i=1}^{m} GE_{i,o} - \sum_{i=1}^{m} Z_{iy,o} \right) * l \tag{33}$$

4. EXPERIMENTAL RESULTS AND ANALYSIS

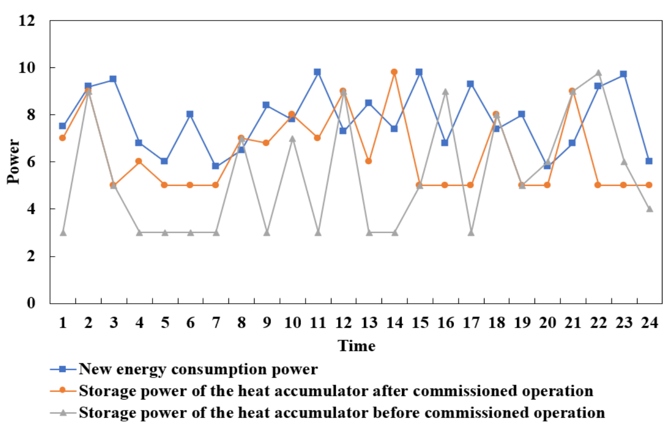

Figure 2. Comparison of the storage power of heat accumulator before and after the commissioned operation

Table 1. Results of commissioned operation

Operation mode	New energy consumption	Power generation cost (yuan)	Energy utilization rate (%)
Independent investment and independent operation	135.26	184752	72%
Independent investment and commissioned operation	174.82	142369	95%
Cooperative investment and independent operation	145.36	195836	83%
Cooperative investment and commissioned operation	186.91	124931	96%

Table 2. Evaluation results of the applicability of 4 investment and operation modes

Indicator		*EX*1	*EX*2	*EX*3	*EX*4	*EX*5	*EX*6	*EX*7	*EX*8
Mode 1	Very high	5	12	6	8	4	7	2	6
	High	5	2	4	1	6	8	2	7
	Average	3	2	5	3	4	2	4	1
	Low	1	0	2	1	1	0	0	1
Mode 2	Very high	2	5	2	7	3	1	5	2
	High	2	5	3	1	4	2	6	1
	Average	8	1	0	2	1	5	3	0
	Low	0	0	2	1	1	1	0	1
Mode 3	Very high	9	5	12	7	5	10	6	8
	High	2	6	4	8	1	7	5	3
	Average	3	4	2	4	6	2	4	1
	Low	1	1	2	2	2	0	1	1
Mode 4	Very high	8	6	2	15	7	2	6	10
	High	4	6	1	7	4	8	5	2
	Average	2	0	6	4	2	1	4	5
	Low	2	1	2	1	1	0	1	2

The electricity purchased by the electric boiler from the distributed new energy power generation company is the amount of new energy consumption. For a calculation example, its daily consumed new energy consumption power and the heat accumulator storage power were simulated, and the results are given in Figure 2. Blue curve in the figure represents the real-time consumption power generated by the new energy power generation company within one operation cycle (24 hours); the orange curve represents the storage power of the heat accumulator within one operation cycle before the commissioned operation, and it is directly related to the heat energy (emitted by the electric boiler) converted from the electricity purchased from the new energy power generation company; the gray curve represents the storage power of the heat accumulator within one operation cycle after the commissioned operation. By comparing these curves, it's known that, the third-party operating unit is entrusted to be responsible for the operation of the heating system, after commissioned operation, it consumed nearly 25MWh new energy electricity more than that before the commissioned operation. After sorting out the daily data of the calculation example, the experimental results under 4 modes are listed in Table 1.

There are four operation modes: independent investment and independent operation (Mode 1); independent investment and commissioned operation (Mode 2); cooperative investment and independent operation (Mode 3); cooperative investment and commissioned operation (Mode 4). In case of independent investment before commissioned operation, the new energy consumption was 135.26MW, the power generation cost was 184,752 yuan, and the energy utilization rate was 72%. While in case of independent investment after commissioned operation, the maximum new energy consumption was 174.82, the increment was nearly 39MW; the power generation cost was 142,369 yuan, the decrement was more than 40,000 yuan; the energy utilization rate reached 95%, the increment was 23%. In terms of the simulation analysis of the cooperative investment situation, after commissioned operation, the new energy consumption was 186.91MW, compared with the value of 145.36MW before commissioned operation, the increment was 41MW; the power generation cost was 195,836 yuan, nearly 70,000 yuan had been saved compared with the value of 124,931 yuan before the commissioned operation; the energy utilization rate was 96%, showing a 13% increment compared with the value of 83% before the commissioned operation. According to these results, the Mode 4 (cooperative investment and commissioned operation) can effectively increase the consumption of new energy and reduce the cost of power generation, which had verified the feasibility and effectiveness of entrusting the operation of the NEH system to a professional third-party operating unit.

Based on the background of the calculation example and the Delphi method, this study selected 8 experts (EX) from different industries and fields and invited them to evaluate the applicability of the four investment and operation modes of the NEH system in a demonstration zone, so as to measure the advantages of the main participants of the NEH system and the complementarity of their advantages and disadvantages. The evaluation results are given in Table 2. As can be seen from the data in the table, the evaluation scores of Mode 4 were higher, indicating that the applicability of this mode was higher and the features of the main participants of the NEH system matched better with this mode.

In the NEH system project of the demonstration zone, under Mode 3 (cooperative investment and independent operation), the State Grid, the distributed new energy power generation company, the thermal power plant, and the regional boiler room can all make investment; under Mode 1 (independent investment and independent operation) and Mode 2 (independent investment and commissioned operation), the State Grid should refuse to invest; under Mode 4 (cooperative investment and commissioned operation), the State Grid can consider to invest, and the distributed new energy power generation company, the thermal power plant, and the regional boiler room should refuse to invest. For the State Grid, it could consider to invest under Mode 3 (cooperative investment and independent operation) and Mode 4 (cooperative investment and commissioned operation). Figure 3 compares the economic benefit under Mode 3 and Mode 4. According to the figure, the net present value of Mode 3 is significantly greater than that of Mode 4, which means that, under Mode 3 (cooperative investment and independent operation), the benefit the State Grid is better, the investment pay-back period is shorter, and the investment risk is lower. Therefore, judging from the perspective of economic benefit, the State Grid should choose to participate in the NEH system project of the demonstration zone under Mode 3 (cooperative investment and independent operation).

For distributed new energy power generation company, it could consider to participate under the four modes, Figure 4 gives the comparison of the economic benefit under these four modes. According to the figure, the net present value of the company under Mode 1 (independent investment and independent operation) is significantly larger than that under the other three modes, that is, under the condition of 8% benchmark yield, the investment benefit of Mode 1 is better, and the benchmark yield and payback period of Mode 2 and Mode 1 differ slightly. Therefore, judging from the perspective of economic benefit, the distributed new energy power generation company should choose to participate in the NEH system project of the demonstration zone under Mode 1 (independent investment and independent operation).

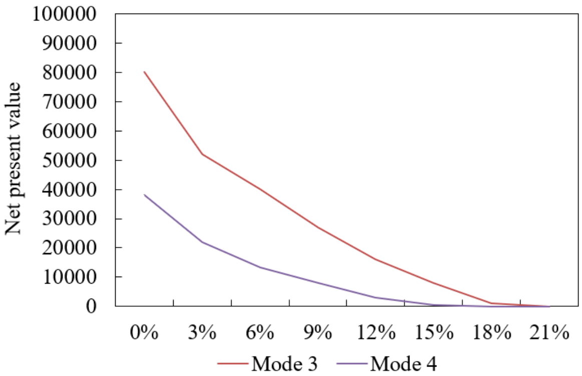

Figure 3. Change of net present value of the State Grid with benchmark yield

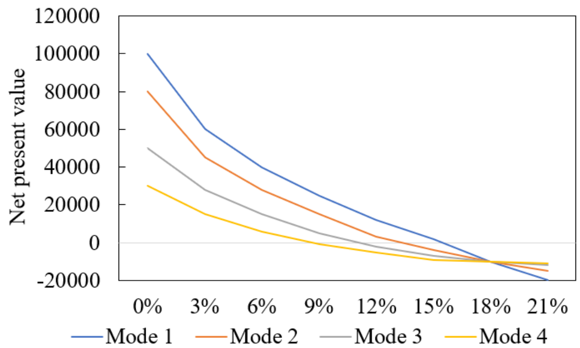

Figure 4. Change of net present value of the distributed new energy power generation company with benchmark yield

5. CONCLUSION

This paper studied the evaluation of the comprehensive cost benefit of the investment and operation modes of NEH system and the ways to improve the said benefit. At first, the paper built an investment and operation model for the NEH system, and constructed an objective function with the minimization of new energy disuse rate as the objective in the commissioned operation scheme for new energy on-spot consumption system connected with large electric heating boiler and large-capacity heat accumulator. Then, the paper gave the structure of the NEH system, and analyzed the main participants, investment and operation modes, and economic benefit of the NEH system.

In the experiment, this paper compared the storage power of the heat accumulator before and after the commissioned operation, and found that, after a third-party operating unit was entrusted to be responsible for the operation of the heating system, it consumed nearly 25MWh new energy electricity more than that before the commissioned operation. According to the results of commissioned operation, the Mode 4 (cooperative investment and commissioned operation) can effectively increase the consumption of new energy and reduce the cost of power generation, which had verified the feasibility and effectiveness of entrusting the operation of the NEH system to a professional third-party operating unit. Moreover, this paper evaluated the applicability of four investment and operation modes, and the experimental results showed that the scores of Mode 4 were higher, indicating that Mode 4 has better applicability and the main participants of the NEH system match better with this mode.

At last, this paper plotted the change curves of net present value of the State Grid and the distributed new energy power generation company with benchmark yield, and inferred that in order to increase benefit, the State Grid should choose to participate in the NEH system project of the demonstration zone under Mode 3 (cooperative investment and independent operation), while the distributed new energy power generation company should choose to participate in the project under Mode 1 (independent investment and independent operation).

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