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Retraction

Retracted: Application of BIM Digital Information Technology in the Economic Optimization Operation of Integrated Energy Systems

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] J. Bu, "Application of BIM Digital Information Technology in the Economic Optimization Operation of Integrated Energy Systems," *International Transactions on Electrical Energy Systems*, vol. 2022, Article ID 7545354, 10 pages, 2022.

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Research Article

Application of BIM Digital Information Technology in the Economic Optimization Operation of Integrated Energy Systems

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Energy is an important support for national economic development, and energy security directly affects national security, sustainable development, and social stability. The Middle East has the largest energy reserves in the world. Saudi Arabia is located in the Middle East and is a big energy country with very rich resources. With the reduction of fossil fuels and the increasingly prominent problem of climate change, the sustainable supply of energy while reducing environmental pollution and economic costs in the process of energy use is a problem facing the world today. In order to fully absorb clean energy, improve energy efficiency, and reduce fuel costs and environmental costs, we studied the impact of BIM digital information technology on the economic optimization of integrated energy systems. The integrated energy system has the characteristics of multienergy input and multienergy output. In terms of energy output, the system uses the principle of energy cascade utilization to recover and utilize the waste heat generated by the traditional generator set and then collects it through absorption. Compared with the traditional single-stage utilization of energy, the integrated energy system uses various forms of power, for example, power, heating, cooling, and natural gas, to achieve economic optimization by improving the comprehensive energy utilization efficiency through multienergy complementation. Through the investigation and comparison of the optimal dispatching operation cost, energy use cost, pollutant treatment cost, and equipment maintenance cost of 3 enterprises, the results show that the comprehensive energy system using BIM digital information technology can reduce the energy use cost by 8.7%. Moreover, the cost of pollutant treatment and the cost of equipment maintenance have been reduced to a certain extent, which has a certain optimization effect on the economy of comprehensive energy of enterprises.

1. Introduction

Saudi Arabia's oil policy includes oil production, price, market share policy, and continued investment in the oil industry to maintain its oil production capacity. These policies are related not only to economic development, social stability, and regime stability but also to the oil policies of countries such as the Organization of the Petroleum Exporting Countries and will also have a significant impact on global economic development. In today's society, energy has already become a global issue, and the energy issue has drawn a lot of focus from countries around the world. The main sources of power today are nonrenewable fossil fuels such as carbon and oil, and the use of fossil energy will pollute the environment to a certain extent. A new form of energy carrying for human society has been proposed, that is, an integrated power system. Since the integrated energy system supplies various forms of energy at the same time, the emission of polluting gas is less than that of ordinary fossil fuel units, and the pollution to the environment is significantly reduced. The integrated energy system can realize the complementary energy supply of electricity, heat, gas, and other energy forms and the multienergy dispatching to meet the load demand, thereby promoting the consumption capacity of renewable energy and improving the comprehensive utilization rate of energy [1]. The application of BIM information technology to an integrated energy system can not only reduce pollutant emissions but also reduce energy costs and optimize the economy of the system.

With the large-scale growth of global energy usage and the increasingly severe global environment, more and more people have begun to study integrated energy systems. On the basis of an evaluation of the building and implementation of microintegrated energy systems, Haibo proposed the economic optimization of its configuration and scale. A natural gas-powered prime mover was designed with wind power, photovoltaic power, and two kinds of stored equipment to provide heat and power for cooling, heating, and power needs [2]. Zhang and Deng combined power generation technologies with other technologies that directly utilize the wasted thermal energy in the electricity produced by generators to improve the operational efficiency and performance of integrated energy systems [3]. Gao et al. built a model to solve an economic scheduling problem that integrates stochastic demand-side responses so that demand can be shifted from peak load times to off-peak load times [4]. Wu et al. proposed a revolutionary dual-loop thermal recuperation and electricity production system to improve thermal recuperation from gas engine (GE) waste gas and jacket cooling water and to increase the power output and thermal capacity of the system [5]. Liu et al. presented a combined cooling, heating, and power (CCHP) system fitted with photovoltaic/thermal (PVT) panels and a microgas turbine (MGT) and absorption chiller. The various parts of the CCHP system use different controllers to process the power by intelligently detecting the external climate. It meets not only the electrical needs of the construction but also the chilling and warming needs [6]. Cesena et al. established a multiobjective excellence model to identify the urban energy system, which can provide electric and thermal energy in an integral power service system in a given area to reduce costs [7]. Barakat et al. of Baha University, Kingdom of Saudi Arabia, proposed a hybrid renewable energy system, which includes integrated energy from photovoltaics, wind turbines, fuel cells, and batteries, reducing the support for HRES from economic and ecological factors [8]. The above studies have shown that the integrated energy system can decrease the production of energy pollution and reduce the use of energy, but the economic feasibility of the integrated energy system has not been analyzed.

BIM digital information technology has applications in many fields, and many scholars have studied BIM digital information technology. Akinade et al. integrated BIM techniques with energy efficiency analysis for the energy-efficient design of buildings. They used BIM technology to create an electronic databank with all the architectural information. By introducing this virtual building model into an energy analytics vehicle, the vast quantity of information in the model is recognized and optimized so that energy performance analysis findings can be accessed rapidly and easily translated by https://www.DeepL.com/Translator (free version) [9]. Zeng et al. developed API plug-ins for commercial BIM tools to assist in the parameterized modelling of CCTV systems and the evaluation of CCTV coverage. A full BIM model of an MRT stop was selected as a sample case in order to examine the CCTV coverage by applying the developed methodology [10]. Li et al. expounded the construction of building information platform based on BIM technology and finally pointed out that the heart of BIM techniques is the shared and exchange of building information [11]. Szelag explored the literature on substantive work on cloud BIM, especially in building lifecycle management, providing practitioners with valuable insights and suggesting avenues for further research [12]. Szwarkowski and Pilecka studied the design of the sliding form system by applying BIM technology to achieve high-impact development of the sliding form system and verify the applicability of the designed sliding form in advance through virtual assembly and construction [13]. Goaszewska and Salamak proposed a new green building design method based on the current state of sustainable architectural design and CAD technology development: BIM technology is combined with building energy saving analysis and imported into building energy saving analysis application, and energy analysis results can be obtained quickly and easily [14]. Zhao discussed the need for training and development of workers in the Arab construction industry, especially the implementation of BIM technology. This enables effective decisions to be made at all stages of the building and structure life cycle, from investment concept to operation and even demolition [15]. Research shows that BIM digital information technology is driving the development of various industries.

A comprehensive energy system is an integrative system that integrates energy generation, distribution, and sales. Its goal is to achieve efficient use of energy, and its realization process is to organically coordinate and optimize energy production, transport, allocation, transformation, storage, and use. From the perspective of medium and long-term planning, the new power system will transition to an integrated energy system in the future, and the power grid will be highly integrated with various infrastructure networks, transforming from a "source-load-driven" integrated energy model of "source-load interaction" [16]. In this paper, the BIM digital information technology is applied to the integrated energy system to rationally use energy and reduce the production of pollutants so as to achieve the purpose of economic optimization.

2. Economic Optimization Methods for Integrated Energy Systems

2.1. Saudi Arabia Energy. Saudi Arabia is the world's largest oil exporter. As an important natural resource, oil has a great influence on Saudi Arabia's economy, society, politics, and politics. Saudi Arabia is an important country in the Middle East, and many academic writings on Saudi politics, economy, and culture have written about Saudi oil policy. In addition to Saudi Arabia's oil production, oil price policy adjustment, and other aspects, there are also domestic and foreign professional oil magazines that publish a lot of information.

Overall, the development process of Saudi Arabia's oil policy has obvious characteristics. The Saudi government has used the oil agency to promote the nationalization of the oil industry and maintain its leadership in the organization by developing the oil industry, thereby making the Saudi oil industry and oil companies more cooperative.

Saudi Arabia's oil policy model is inextricably linked to the political and economic impacts it faces at home and abroad. Saudi Arabia must rely on oil revenue to support its sustainable development, and it must ensure the continuous and steady growth of its oil revenue to maximize its economic benefits. On the one hand, Saudi Arabia must maintain the country's long-term stability and the country's external security, and on the other hand, it must maintain close political and economic relations with Western countries. It is necessary to ensure the reasonable fluctuation of international oil prices so that it is in a favorable position in the stability and development of the global economy.

On the basis of synthesizing various political and economic interests, the Saudi government's "moderate and balanced" governing policy has been formulated. It aims to maintain a long-term supply and demand balance in the oil market, increase the proven reserves of oil, increase oil production capacity, and retain existing production capacity.

This determines an oil policy model that Saudi Arabia adopts in the process of Saudi economic integration, namely, the International Petroleum Organization and the increasingly internationalized oil industry.

The internationalization path of the Saudi domestic oil industry is, as stated by the Saudi oil minister at the Asian session of the World Petroleum Congress, "In the past 60 years, the development of Saudi Arabia's oil industry has been obvious to all. Saudi Arabia has developed from a single small oil-producing country into an integrated oil-producing country with abundant oil reserves and oil production capacity. In the first 30 years, we were committed to increasing the national oil production and export capacity, and after the 30s, the oil industry has shown the characteristics of diversification and international development." In the next 30 years, it was in the 1970s that Saudi Arabia carried out the diversification and international development of the oil industry independently after it took back the oil industry enterprises with foreign capital. The Saudi government cooperates with members of the Organization of Arab Petroleum Exporting Countries and the Gulf Cooperation Council to build joint ventures and develop the oil industry. At the same time, Saudi Arabia has carried out industrial upgrading and overseas mergers and acquisitions with state-owned oil companies as its main force, especially Saudi Aramco, which contributes to Saudi Arabia's continued competitiveness in the international oil market.

2.2. Structure Diagram of Integrated Energy Systems. The comprehensive energy systems are characterized by multienergy inputs and multienergy outputs [17]. In terms of energy output, the system uses the principle of energy cascade utilization to recycle and utilize the exhaust heat generated by the traditional generator set and then discharged through the absorption set. The principle is similar to that of a thermoelectric power station, in which the low-boiling working fluid "absorbs energy" to drive the generator. This produces various forms of energy, which can meet the various load requirements of different users and can also reduce the emission of polluting gases, which has good economic and social benefits [18]. The schematic diagram is shown in Figure 1.

To reduce the influence of the randomness of wind energy and solar power generation on the operation of the grid after grid connection and to achieve the effect of maximizing energy utilization, according to the characteristics of real-time power balance and thermal stage balance, control methods such as frequency sensing controller or grid-connected power controller can be used to connect wind power and photovoltaics to power supply and heating, respectively, effectively adjusting grid-connected power, so that the energy is absorbed in the heat network.

2.3. Mathematical Model of a Combination of Cooling, Heating, and Energy Supply Systems. Cold, heat, and electricity cogeneration, or CCHP, refers to the application of natural gas to drive the functioning of gas-fired power generating facilities, such as gas turbines, microcombustion engines, or electric combustion turbines, using natural gas as the primary source of fuel. The power produced supplies the electricity demand of the user. The exhausted waste thermal energy from the system is recovered and utilized to provide heat and cooling to the customer [19]. CCHP systems usually consist of a gas engine (or inboard ignition engine, microcombustion engine), waste heat boiler, absorption chiller, and also a combination of microcombustion engine and bromine chiller, which can realize triple supply of cooling, heating, and power. Figure 2 is a graphical representation of a combined procedure of the triple supply of the gas-fired unit, the waste heat boiler, the steam unit, the heat exchanger, and the refrigerator. The figure is a more complex gas-steam combined cycle system. The combustion of natural gas and air in the gas turbine drives the steam turbine to rotate to generate power. High-temperature and high-pressure smoke residual heating after doing work enters the steam turbine to spin the steam turbine to rotate to produce power. After the steam turbine does work, the waste heat is passed through the heat converter and the refrigeration mechanism to obtain hot and cold water of lower energy quality, which truly achieves a graded use of energy and increases energy efficiency. Figure 2 shows the principle diagram of a common CCHP system.

2.4. Energy Feed Switching Solutions for Coordinated Control of Electricity, Power, and Heat from Renewable Sources. To reduce the influence of the randomness of new energy power generation on the grid-connected system, control methods such as frequency sensing controller or grid-connected power controller can be used. The control mode is illustrated in the principle diagram in Figure 3. It determines the access system by sensing the frequency or power of the grid, thereby controlling the total amount of renewable energy power supply [20].

In this paper, a controller is added to connect the power generated by the new energy to the power supply and heating systems, respectively, so as to realize the

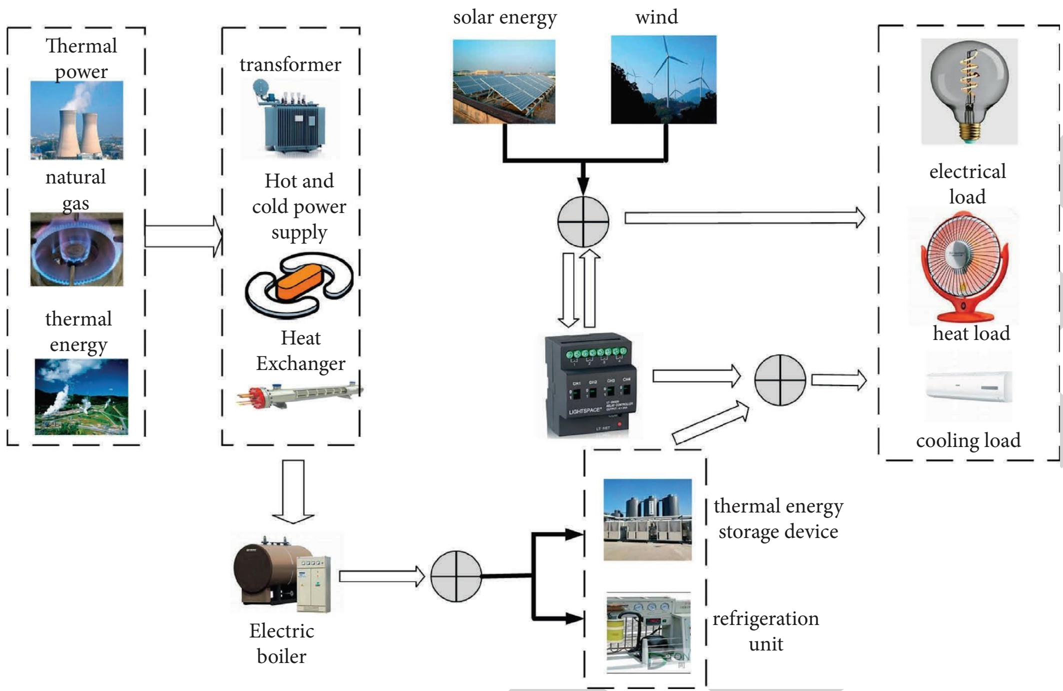

Figure 1: Structure diagram of the integrated energy system.

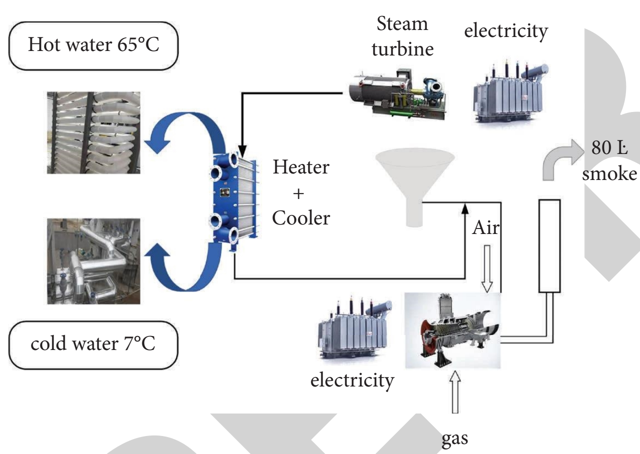

Figure 2: Mathematical model of the combined cooling, heating, and power system.

controllable, adjustable, or fixed value of the grid-connected power of the new energy generation.

2.5. BIM Model Construction. The BIM model is the most direct reflection of the application of BIM technology. It provides data support for each stage of the project through data integration, proofreading, processing, and analysis. The BIM process defines the behavior of information exchange between project participants. The task of this paper is to determine the content of the project exchange for each creator and receiver of the energy system information exchange, as shown in Figure 4. As an information integration and management technology based on a visual building information model, BIM has inherent advantages such as synergy, visualization, simulation, optimization, cost saving, coconstruction, and sharing.

It is necessary to define each information exchange in the model, in which the information exchange between two project participants must be defined so that all parties involved are aware of the progress of the system and what the corresponding BIM deliverables are. It selects the model element decomposition structure for the system, standardizes the definition of information exchange content, determines the input and output information requirements of each information exchange, and assigns the responsible party to create the required information. In general, the information creator should be the project participant with the easiest access to the information at the point in time of the information exchange. Comparing input and output content, after the information exchange content is determined, the project team summarizes the system information.

3. Comprehensive Energy System Economic Optimization Model Algorithm

3.1. Fuel Cost. The power provision of an integrated energy system consists mainly of electricity generation, heating or cooling only, and cogeneration systems. According to the different characteristics of the fuel cost, the fuel cost in three different situations can be obtained [21]:

(1) The fuel cost for the generator set alone is

$$C_i(p_i(t)) = a_i + b_i p_i(t) + c_i p_i^2(t), \quad i = 1, 2, \ldots, N_P. \tag{1}$$

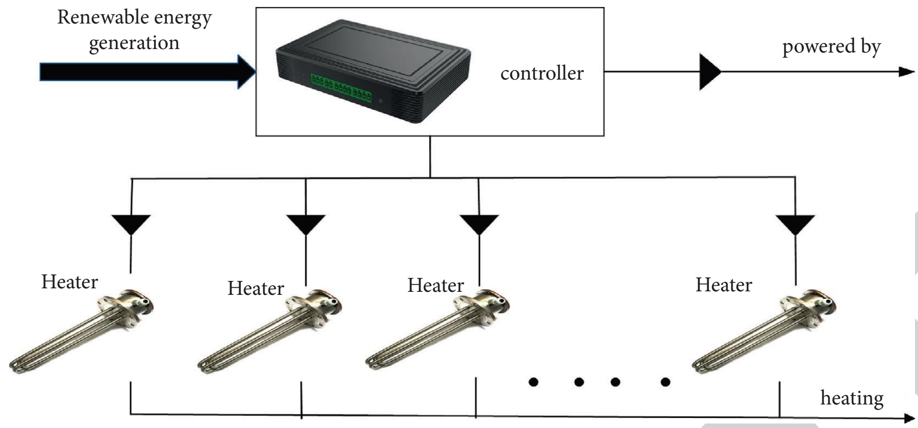

Figure 3: Schematic diagram of energy supply switching for renewable energy generation.

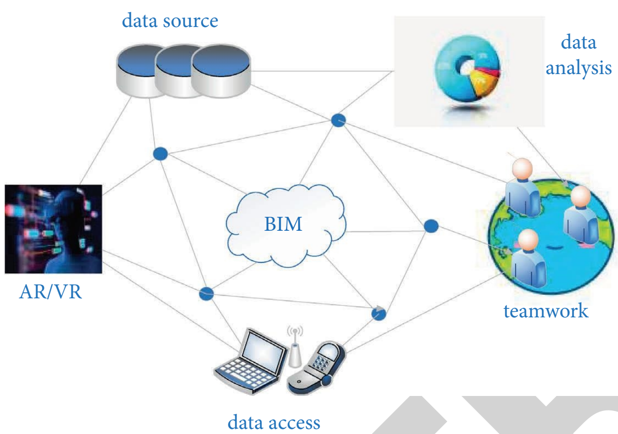

Figure 4: BIM model construction.

In the formula, $C_i(P_i(t))$ is the fuel cost required to generate thermal power of $p_i(t)$ for the ith generator set only for power generation in term t.

(2) The fuel cost of the heating (cooling) unit only is

$$C_k(P_k(t)) = a_k + b_k H_k(t) + c_k H_k^2(t), \quad k = 1, 2, \ldots, N_h. \tag{2}$$

In the formula, $C_k(P_k(t))$ is the fuel cost required to generate the heating power or cooling power of $H_k(t)$ when the kth energy source only provides heating or cooling in term t.

(3) The fuel price of a combined energy cogeneration device is

$$\begin{aligned} C_j\left(P_j(t), H_j(t)\right) &= a_j + b_j p_j(t) + c_j p_j^2(t) + \delta_j H_j(t) \\ &\quad + \theta_j H_j^2(t) + \varepsilon_j P_j(t) H_j(t), \\ j &= 1, 2, 3, \ldots, N_c. \end{aligned} \tag{3}$$

In the formula, $C_j(P_j(t), H_J(t))$ is the fuel price required for the jth cosupply system to generate electric power of P_j and heating and cooling power or cooling power of H_j in the tth period.

To sum up, the fuel price of all devices in period t; that is, the total fuel cost is

$$f_1^t = \sum_{i=1}^{N_P} C_i(P_i(t)) + \sum_{k=1}^{N_h} C_k(H_k(t)) + \sum_{j=1}^{N_c} C_j\left(P_j(t), H_j(t)\right). \tag{4}$$

In the formula, a, b, c, δ, θ, and ε stand for the factor of the fuel price model, respectively; N_P, N_h, and N_c stand for the number of energy sources for power generation only, heating or cooling only, and integrated energy cogeneration, respectively.

3.2. Environmental Cost

3.2.1. Carbon Emission Equivalent Conversion Factor. The three main pollutant gases emitted by the integrated energy system during the actual operation are CO_2, SO_2, and NO_X. By comparing the emissions of these three types of gases per unit of production capacity, the equivalent relationship between the emissions of CO_2, SO_2, and NO_X can be obtained [22], that is, the carbon emission equivalent conversion factor ε:

$$\begin{aligned} \varepsilon_{SC} &= \frac{e_{so_2}}{e_{co_2}}, \\ \varepsilon_{NC} &= \frac{e_{NO_X}}{e_{co_2}}. \end{aligned} \tag{5}$$

In the formula, e_{co_2}, e_{so_2}, and e_{NO_x} are the emissions corresponding to the unit production capacity, respectively, ε_{SC} is the conversion coefficient of converting SO_2 gases to CO_2 gases, and ε_{NC} is the conversion coefficient of converting NO_2 gases to CO_2 gases. e_{co_2} is the amount of emissions from CO_2. e_{so_2} is the amount of emissions from SO_2.

3.2.2. Emission Model of Polluting Gas. In the system, it is necessary to quantify the emission of polluting gases, which includes 3 parts: only electricity is generated, only heating or cooling, and gas exhaust from the cogeneration part. It is possible to take into account only the emissions of CO_2 gas, while the emissions of the other two gases, SO_2 and NO_X, are considered in the model by converting them to CO_2 gases.

The CO_2 emission function for electricity generation only is

$$E_{CO_2 i}(P_i(t)) = 0.01\left[\alpha_i + \beta_i P_i(t) + \gamma_i P_i^2(t)\right] + \varepsilon_i \exp(\lambda_i P_i(t)). \quad (6)$$

Then the corresponding SO_2 and NO_X emission functions are

$$\begin{aligned} E_{SO_2 i}(P(t)) &= \varepsilon_{SC} E_{CO_2 i}(P_i(t)), \\ E_{NO_X i}(P_i(t)) &= \varepsilon_{NC} E_{CO_2 i}(P_i(t)). \end{aligned} \quad (7)$$

The CO_2 emission function corresponding to the integrated energy cogeneration system is

$$E'_{CO_2 i}\ (P_i(t)) = 0.01\left(1 + \frac{1}{\rho}\right)\left[\alpha_i + \beta_i P_i(t) + \gamma_i P_i^2(t) + \varepsilon_i \exp(\lambda_i P_i(t))\right]. \quad (8)$$

Then the corresponding SO_2 and NO_X emission functions are

$$\begin{aligned} E'_{SO_2 i}\ (P_i(t)) &= \varepsilon'_{SC}\ E'_{CO_2 i}\ (P_i(t)), \\ E'_{NO_x i}\ (P_i(t)) &= \varepsilon'_{NC} E'_{CO_2 i}\ (P_i(t)). \end{aligned} \quad (9)$$

The CO_2 emission function corresponding to only the hot (cold) part is

$$E''_{CO_2 i}(P_i(t)) = \frac{0.01\left[\alpha_i + \beta_i P_i(t) + \gamma_i P_i^2(t) + \varepsilon_i \exp(\lambda_i P_i(t))\right]}{\rho}. \quad (10)$$

Then NO_X and emission functions corresponding to SO_2 are

$$\begin{aligned} E''_{SO_2 i}(P_i(t)) &= \varepsilon''_{SC}\ E''_{CO_2 i}(P_i(t)), \\ E''_{NO_X i}(P_i(t)) &= \varepsilon''_{NC}\ E''_{CO_2 i}(P_i(t)). \end{aligned} \quad (11)$$

In the formula, $p_i(t)$ is the active power output of the ith generator at time t; $\propto_i$, β_i, λ_i, γ_i, and ε_i are the CO_2 gas emission parameters of the ith distributed power generation, respectively; ρ is the heat supply equivalent performance coefficient. The emissions of these exhaust gases pollute the atmosphere, the hazards to human health mainly include chemical substances such as nitrogen oxides, sulfur dioxide, carbon monoxide, and volatile organic compounds, causing cough and sore throat, and carbon monoxide can also cause asthma, heart disease, and other diseases.

To sum up, the environmental cost is mainly aimed at the environmental losses caused in the production process, that is, the fines that should be imposed on the pollutants discharged.

3.2.3. Power Purchase Cost. The establishment of wind farms and solar farms costs a lot of cost, and the maintenance of the equipment during operation requires costs. When considering its electricity selling price as a single fixed electricity price, its electricity purchase cost can be obtained as

$$f_3^t = \lambda_w P_w(t) + \lambda_s P_s(t). \quad (12)$$

Among them, λ_w is the unit price of wind power sales, $P_w(t)$ is the power of wind power within t period, λ_s is the unit cost of solar energy generation, and $P_S(t)$ is the power of solar power generation within t period.

3.2.4. Total Cost. In the whole dispatching period T, the total environmental protection and economic comprehensive cost of all units, including fuel cost, environmental cost, and power purchase cost, is

$$f_{all} = \sum_{t=1}^{T}\left(f_1^t + f_2^t + f_3^t\right). \quad (13)$$

In the formula, T is the scheduling period; f_1^t is the fuel cost in the term t; f_2^t is the environmental cost in the term t; f_3^t is the power buying fees in the term t.

3.3. Economic Optimization Model of Integrated Power Systems

3.3.1. Objective Function. The scheduling considered in this paper aims to minimize the total of fuel costs, environmental costs, and the cost of buying electricity, so the objective function is

$$f = \min(f_{all}) = \min\left(\sum_{t=1}^{T}\left(f_1^t + f_2^t + f_3^t\right)\right). \quad (14)$$

Among them, f_1^t, f_2^t, and f_3^t are the fuel cost, environmental cost, and power buying cost in term t, and T is the dispatch period.

3.3.2. Balance Constraints

$$\sum_{i=1}^{N_P} P_i(t) + \sum_{j=1}^{N_C} P_j(t) + P_w(t) + P_s(t) = P_D(t), \quad (15)$$

$$\sum_{t}^{t+\Delta t}\left[\sum_{j=1}^{N_c} H_j(t) + \sum_{k=1}^{N_b} H_K(t)\right] = \sum_{t}^{t+\Delta t} H_D(t). \quad (16)$$

Formula (15) is a constraint on the real-time balancing equity for electricity, and formula (16) is a constraint on the balancing equation for the thermal generation phase. These two equations belong to the constraint class of equations. Among them, Δt is the phase-balance delay value of thermal energy, which can be determined according to the requirements of the heating quality and heating level [23].

4. Experiment Design for Economic Optimization of Integrated Energy System

4.1. Experimental Process. In this experiment, three energy companies with similar scales were randomly selected. Enterprise A adopts the integrated energy system based on

Table 1: Energy usage of three companies.

	Size	Number of companies	Primary energy use	Years of opening
Company A	Medium enterprise	80	Oil and natural gas	5 years
Company B	Medium enterprise	69	Oil and natural gas	6 years
Company C	Medium enterprise	75	Oil and natural gas	5 years

BIM information technology to manage the enterprise energy, enterprise B adopts the traditional integrated energy system to manage the enterprise, and enterprise C adopts the traditional single-stage energy utilization system to manage the enterprise. It conducts a six-month follow-up test on companies to observe the economics of the two companies' energy systems each month. Through the investigation and comparison of the optimal dispatching operation cost, energy use cost, pollutant treatment cost, and equipment maintenance cost of the enterprise, it is observed how BIM digital information technology can optimize the economy of the integrated energy system.

4.2. Experimental Data. This experiment randomly selects three medium-sized energy enterprises in a certain place for follow-up investigation. In order to avoid experimental errors, the energy usage of the three selected enterprises is not much different, and the specific data of the enterprises are shown in Table 1.

4.3. The Purpose of the Experiment. The experiment aimed to validate the effectiveness of the economic optimum operation model and optimization algorithm for comprehensive energy systems with multiple types of energy conversion and storage presented in this paper and to explore the influence of BIM digital information technology on the system economy of external energy supply constraints.

5. Economic Optimization Results of the Integrated Energy System

The combined cooling, heating, and power system is one of the most important forms of distributed energy systems. Due to its significant comprehensive benefits in terms of energy consumption, economy, and environment, it has received extensive attention and applications at home and abroad in recent years.

5.1. Optimizing the Scheduling Operation Cost. The dispatch period of the integrated system economic dispatch operation model of the three enterprises is set to be 6 months, and the dispatch interval is set to be 1 month. According to the parameters of the calculation example set above, the test of the optimal dispatching operation cost is solved by three dispatching operation strategies, cooling load, heat load, and electric compliance, and the dispatching results are analyzed and compared.

5.1.1. Cooling Load Scheduling Test. Among them, the cooling load scheduling operation strategy is mainly to test absorption chillers, electric chillers, and cooling loads. The test results are shown in Figure 5.

As can be seen from the graph, the optimal scheduling consumption of cooling load of company A is gradually decreasing, and the rate is the fastest; the optimal scheduling consumption of cooling load of company B is also gradually decreasing, but the rate is slower; the optimal scheduling consumption of company C has been fluctuating, increasing, and decreasing. Among them, the scheduling consumption of company A has decreased by 30,000 yuan after the 6-month test, the scheduling consumption of company B has been reduced by 15,000 yuan after the 6-month test, and the scheduling consumption of company C has little fluctuation before and after the 6-month test.

5.1.2. Heat Load Scheduling Test. Among them, the heat load scheduling operation strategy is mainly to test the heat exchanger, electric boiler, and heat load. The test results are shown in Figure 6.

As can be seen from the graph, compared with the cooling load dispatching, the three enterprises have more consumption costs for the heating load. The thermal load optimization scheduling consumption of enterprise A is gradually decreasing every month, and the decreasing rate is the fastest. The thermal load optimization scheduling consumption of company B is also gradually decreasing but at a slower rate. The thermal load optimization scheduling consumption of enterprise C has been fluctuating, increasing, and decreasing. Among them, the dispatching consumption of company A has decreased by 40,000 yuan after the 6-month test, the scheduling consumption of company B has been reduced by 20,000 yuan after the 6-month test, and the scheduling consumption of company C has little fluctuation before and after the 6-month test.

5.1.3. Electric Load Scheduling Test. Among them, the electric load dispatching operation strategy is mainly to test the microgas turbine, the power purchase of the grid, and the electric load. The test results are shown in Figure 7.

As can be seen from the graph, the electricity load consumption cost of the three enterprises is the most. The electricity load optimization dispatching consumption of enterprise A is gradually decreasing every month, and the decrease rate is the fastest compared to that of the heating and cooling load. The power load optimization scheduling consumption of enterprise B is also gradually decreasing, but the decreasing rate is

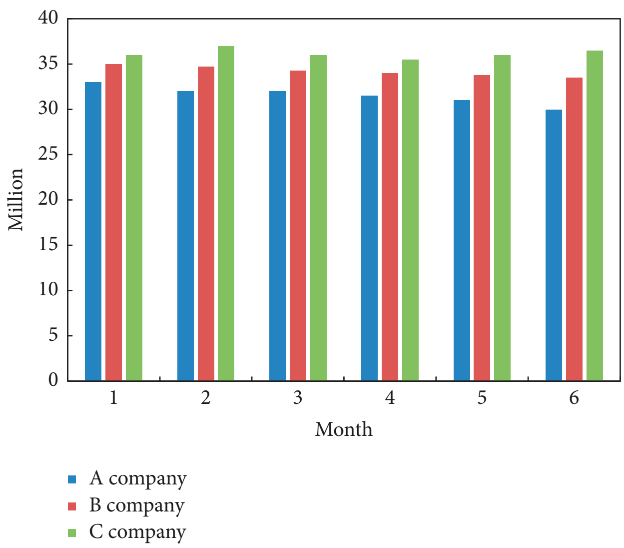

Figure 5: Cooling load scheduling.

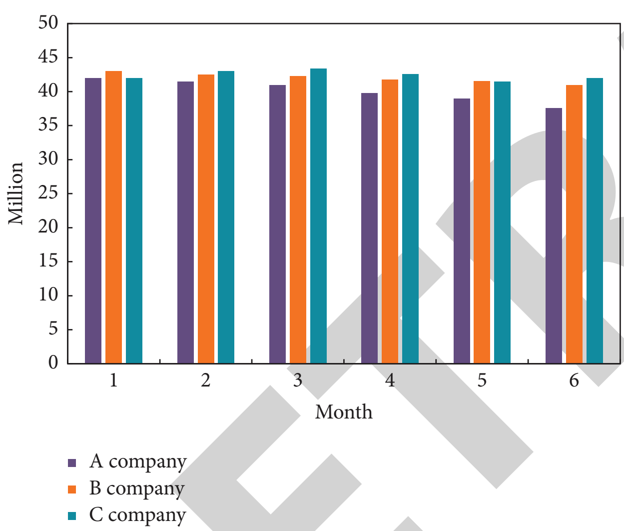

Figure 6: Heat load scheduling.

slower. The electricity load optimization dispatching consumption of enterprise C has been fluctuating, increasing, and decreasing. Among them, the dispatching consumption of company A has decreased by 40,000 yuan after the 6-month test, the scheduling consumption of company B has been reduced by 20,000 yuan after the 6-month test, and the scheduling consumption of company C has little fluctuation before and after the 6-month test.

Through the investigation of the three companies' cooling load, heating load, and electricity compliance with three scheduling operation strategies, it is found that the optimal scheduling operation cost consumption of company A is the smallest, and the reduction rate is the fastest. It can be seen that the integrated energy system on the basis of BIM information technology can greatly reduce the optimal dispatching operation cost of enterprises.

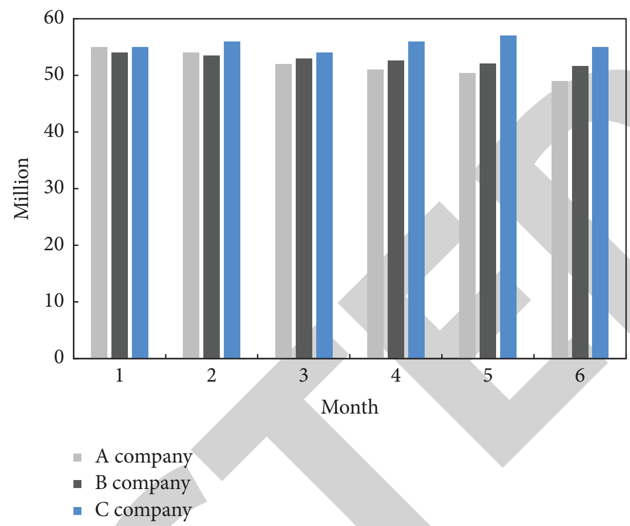

Figure 7: Electric load scheduling.

5.2. Cost of Energy Use. Carry out a 6-month follow-up survey of energy use costs for three enterprises, and count the results every month to observe the impact of different energy management systems on the energy use of enterprises. The results are shown in Figure 8.

As can be seen from the graph, the energy usage of company A is flat after a rapid decline. The energy usage of company B has decreased slightly. Company C's energy usage was stable and flat. The 6-month energy use cost of company A has decreased by 160,000 yuan, the 6-month energy use cost of company B has decreased by 90,000 yuan, and the energy use of company C has not changed significantly. The energy use cost of company A is 8.7% lower than that of company B. As can be seen, the comprehensive energy system on the basis of BIM information technology can help enterprises to use energy effectively and reduce the cost of energy use.

5.3. Equipment Maintenance Costs. Carry out a 6-month follow-up survey of equipment maintenance costs for three enterprises, and count the results every month to observe the impact of different energy management systems on the equipment maintenance costs of enterprises. The results are shown in Figure 9.

As can be seen from the graph, the maintenance cost of company A is the most stable, and there is no major expense. Company B has 3 major expenses within 6 months, and company C has 4 major expenses within 6 months. As can be seen, the comprehensive energy system on the basis of BIM information technology can more reasonably use the equipment of the enterprise, reduce the occurrence of equipment failure, and greatly reduce the expenditure of the enterprise on equipment repair costs.

5.4. Pollutant Treatment Costs. Conduct a 6-month follow-up survey of pollutant treatment costs for three companies, and count the results every month to observe the impact of different energy management systems on the company's pollutant treatment costs. The results are shown in Figure 10.

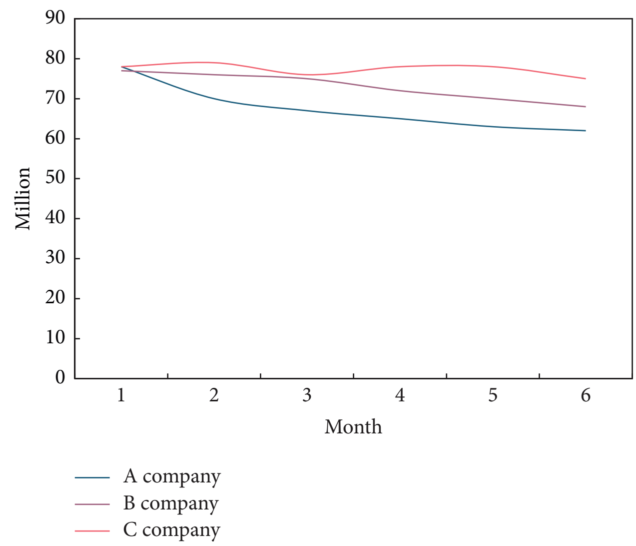

Figure 8: Energy use cost test.

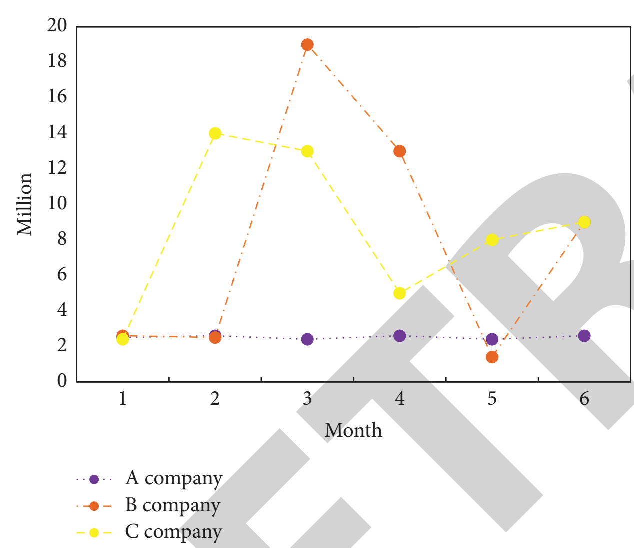

Figure 9: Equipment maintenance costs.

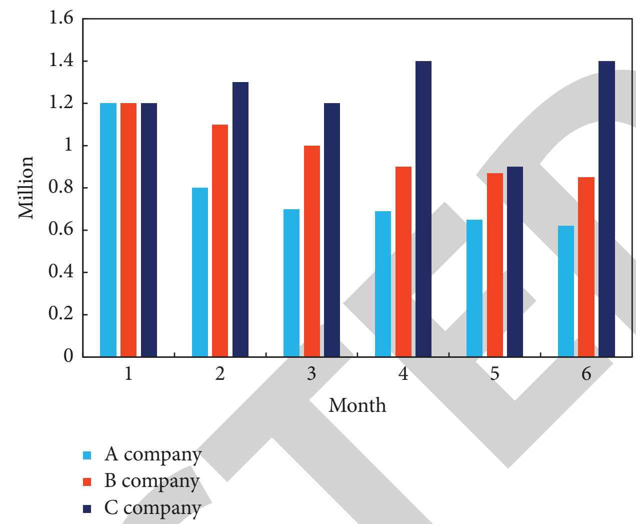

Figure 10: Pollutant treatment costs.

As can be seen from the graph, the pollutant treatment cost of company A gradually decreases after the rapid reduction. The pollutant treatment cost of company B decreased slightly. The pollutant treatment cost of company C was stable and flat, followed by component growth. The 6-month pollutant treatment cost of company A decreased by RMB 5,800. The 6-month pollutant treatment cost of company B decreased by 3,500 yuan. There was no significant change in the energy usage of company C. As can be seen, the comprehensive energy system on the basis of BIM information technology can help enterprises reduce the production of pollutants and reduce the cost of pollutant treatment.

6. Discussion

The flourishing of scientific and technological advances, resource depletion, and environmental risks are of great concern. On the basis of the principle of BIM information technology, it also has its share of effective energy use when meeting the needs of enterprises for a wide range of loadings, including cold, heat, and power. It has the important feature that pollution is significantly reduced to reduce the cost of energy use and the cost of pollutant treatment. Therefore, the system has an immeasurable effect on economic, environmental, and social benefits. In order to keep up with economy and to save resources and protect the environment, an in-depth study of the operational excellence of comprehensive energy systems can lead to energy efficiency and savings and reducing emissions as soon as possible.

7. Conclusions

The integrated energy system is a complex integrated system because it has both various forms of energy supply and various types of load consumption, so its operation optimization involves all aspects of the field. This paper discusses that the integrated energy system based on BIM information technology brings optimization to the enterprise economy and can reduce the number of pollutants produced by the enterprise. The rational use of energy reduces the amount of energy used, the equipment can be used reasonably, and the repair cost of the equipment can be reduced, which has a certain optimization effect on the economy of the enterprise. BIM digital information technology has a very good role in promoting the economic optimization of the integrated energy system.

Data Availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Conflicts of Interest

The author declares that there are no conflicts of interest regarding the publication of this article.

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