Research on the Power Transformation Method of Renewable Energy in Industrial Park Based on Improved Genetic Algorithm

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Abstract: The transformation of renewable energy power in industrial park, as an important measure to improve energy efficiency, optimize energy application structure, and implement the social concept of green environmental protection development. Then, the research on the transformation method of renewable energy power in industrial parks based on the improved genetic algorithm, Focusing on considering the current methods of energy management in integrated energy systems, By building the operating model of renewable energy systems, Construct the efficiency and economic model of the key components in the system, And based on the operation and maintenance of energy equipment and the energy conversion cost of the industrial park and the main network, Establish an objective function of the cost of generating electricity from renewable energy sources, After improving the coding method of energy management time sequence problem, Proposed a new optimization algorithm for renewable energy in industrial parks, So as to verify the implementation and effectiveness of the content of this study.

Keywords: improving genetic algorithm; industrial park; renewable energy power; transformation method

1. Introduction

Energy, as the main driving force for human development, is the foundation of human social progress. In the current era, there is a huge demand for energy application, and under the huge energy demand, the development and use of energy are very large. At the same time, it causes serious pollution to the environment. So, in order to protect the sustainable natural environment, humans enrich the application structure of traditional energy by developing clean energy, while reducing the consumption of non renewable energy, in order to achieve the goal of reducing environmental pollution. As an inevitable product of urban industrialization and urbanization, industrial parks account for more than half of the energy consumption of various industrial industries in China. Moreover, most industries use disposable energy, which can cause great waste in energy application[1].Therefore, transforming the energy structure of industrial parks, improving their internal energy utilization rate, further strengthening the management of renewable energy in industrial parks, ensuring the stability and reliability of energy supply within industrial parks, and alleviating the problem of energy shortage in China.

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2. Composition and Component Model of the Renewable Energy System in the Industrial Park

The micro-grid composed of various types of energy preservation and conversion components, energy transmission and various loads of the industrial park can exchange electricity and natural gas energy with the superior power grid and gas grid[2], as shown in Figure 1. The derived energy energy preservation and conversion elements include a variety of equipment and energy storage devices, and the load is mainly divided into three types, namely electricity, heat and cold; distributed generation is the main power load in the industrial park, which cannot meet the heat and cooling load, and can only transfer the remaining power to the power storage device, or to the superior grid, and complete the power supply according to the time-sharing power price. In addition, the heat energy can be stored using the corresponding energy storage device, thus supplying the energy at the appropriate time period.

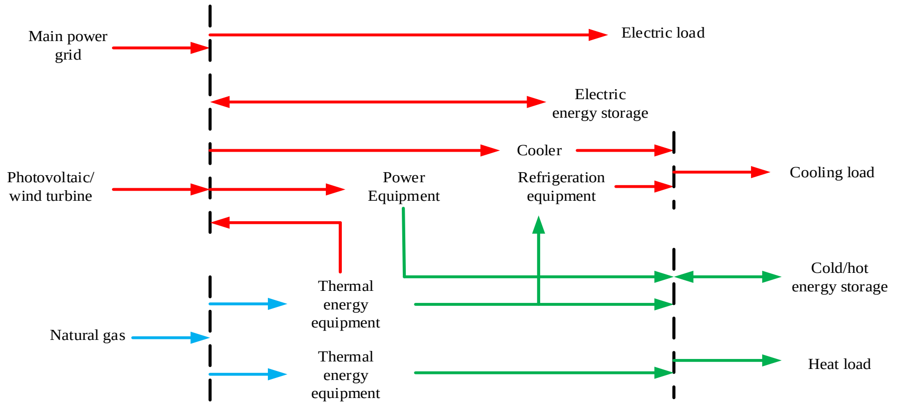

Figure 1. Structure of the renewable energy system in the industrial park

The economic model of system components consists of three items, namely, gas internal combustion engine, gas boiler and energy storage system. First, the formula of gas internal combustion engine is:

$$C_{MT}(t) = C_{CH4} \frac{p_{MT}(t)\Delta t}{\eta_{MT}(t) L_{HVNG}} \tag{1}$$

Where △ t is the unit scheduling time; $C_{MT(t)}$Fuel cost for gas equipment; C_{CH4}Unit price of natural gas; L_{HVNG}For the low calorific value of natural gas; $P_{MT(t)}\eta_{MT}(t)$Electric power of fuel gas equipment; power generation efficiency of thermal energy equipment.

The second isThe gas-fired boiler formula is expressed as follows:

$$C_{GB}(t) = C_{CH4} \frac{H_R(t)\Delta t}{\eta_{GB}(t) L_{HVNG}} \tag{2}$$

Where, $C_{GB}(T)$ is for the fuel cost; $H_R(t)$ is thermal power;$\eta_{GB}(t)$For the heating efficiency of the internal combustion equipment.

ultimatelyEnergy storage system formula states:

$$C_b = \frac{Q_d}{N_d} n_d \quad (3)$$

In e. g_dCost cost for energy saving equipment; N_dFor the cycle service life; n_dFor the number of cycles in the scheduling time.

3. Renewable Energy in Industrial Park, Source System Economic Scheduling Model

As a centralized control system, the renewable energy system in the industrial park. The renewable energy generation cost in the park mainly includes three costs: fuel[3], equipment start and stop, energy exchange in the park and main network. The formula is as follows:

$$\min C = C_\mathrm{f} + C_\mathrm{s} + C_\mathrm{g} \quad (4)$$

In formula C_fFor fuel; C_sStart and stop for the equipment; C_gEnergy exchange for the master network.among

$$.C_f = \beta(G_{GT} + G_{GB})C_S = max\{0, \ U(t) - U(t-1)\}U_{MT} + \frac{Q_d}{N_d} n_d C_g = \sum_{t=1}^{24} C_P(t)P_{GP}(t) \quad (5)$$

The constraints are divided into six items, namely heat balance, power balance, cold power balance, gas equipment climbing power constrain[4]t, battery operation constraint, reliability constraint, the formula is expressed as (6-13).

$$H_{GT}^{out}(t) + H_{GB}^{out}(t) + H_{EB}(t) = H_{AR}^{in}(t) + H_D^h(t) + H_L(t) \quad (6)$$

In formula $H^{out}{}_{GT}(T)$ is excess heat of gas equipment; $H^{out}{}_{GB}(T)$ the heat generation for the heating unit; $H_{EB}(T)$ generate heat for electric boiler; $H^{in}{}_{AR}$Heat is required for the refrigeration unit; $H_D{}^h(t)$ User heat load; $H_L(t)$ for heat transfer consumption.

$$P_{GP}(t) + P(t) + P_I(t) = P_D(t) + P_{AR}(t) + P_{EB}(t) + P_L(t) \quad (7)$$

In formula $P_{GP}(t)$ supplies electricity for the public network; P (t) for the gas equipment; $P_I(t)$ Power for distributed power supply; $P_D(t)$ user load; $P_{AR}(t)$ consumption consumption for refrigeration equipment; $P_{EB}(t)$ power consumption for electric boiler; $P_L(T)$ for the power transmission consumption.

$$H_{AR}^{\mathrm{out}}(t) + H_{ER}^{\mathrm{out}}(t) = H_D^{\mathrm{c}}(t) + H_L(t) \quad (8)$$

In formula $H^{out}{}_{AR}(t)$ is the cooling capacity of refrigeration equipment; $H^{out}{}_{ER}(T)$ is the cooling capacity of the cooler; $H^c{}_D(t)$ for cooling load consumption; $H_L(t)$ For the transmission cooling consumption.

$$P_{down} \le P_{MT}(t) - P_{MT}(t-1) \le P_{up} \quad (9)$$

In formula P_{down}Is the lower limit of the climbing power; P_{up}Is the upper limit of the climbing power.

$$P_{ES,\ \min} \le P_{ES} \le P_{ES,\max} \tag{10}$$

$$E_{ES,\ \min} \le E_{ES} \le E_{ES,\max} \tag{11}$$

In formula P_{ES}For the battery operating power; $P_{ES,max}$Is the upper battery operating power limit; $P_{ES,min}$Is the lower operating power limit of the battery; E_{ES}Is the battery capacity; $E_{ES,max}$Is the upper battery capacity limit; $E_{ES,min}$Lower limit of the battery capacity.

$$E_{LOEE} \le E_{LOEE,\max} \tag{12}$$

$$H_{\mathrm{LOEE}} \le H_{\mathrm{LOEE},\ \max} \tag{13}$$

In ELOEE and ELOEE, max is the expected energy supply and maximum energy supply expectations of the renewable energy system in the industrial park; HLOEE and HLOEE, max is the expected energy supply and maximum heat supply energy expectations of the renewable energy system in the industrial park.

4. Algorithm Case Analysis

The industrial park in northern China is selected, and the latest intelligent distributed energy system is created in the industrial park. At the same time, all conditions are set as the initial optimal conditions, so that they have the basis to meet the operation of the algorithm[5-7]. The relevant parameters are set as shown in Table 1.

Table 1 Table of parameter parameter related to algorithm cases

Unit operation and maintenance parameters		
type	power rating:MW	Maintenance cost: kW · h^{-1}, first
Thermoelectric unit equipment	150	0.095
electric boiler	10	0.050
Gas device	15	0.045
Cold machine	20	0.038
Electric energy storage equipment	8	0.083
Thermal energy storage equipment	4	0.045
Electricity price over the time period		
period	time quantum	unit-price:kW·h^{-1}, first
fastigium	10-15,18-21	0.8
stationary phase	7-10,15-18,21-23	0.5
low ebb	0-7,23-24	0.2

In summer and winter, due to geographical factors, cold and hot loads rarely appear at the same time, so it needs to be discussed separately. However, because the load in summer only shows electric and cold, electric boilers and gas equipment do not need to operate, so focus on the situation in summer.

First, the summer load situation and the winter load of the industrial park are predicted, as shown in Figure 2.

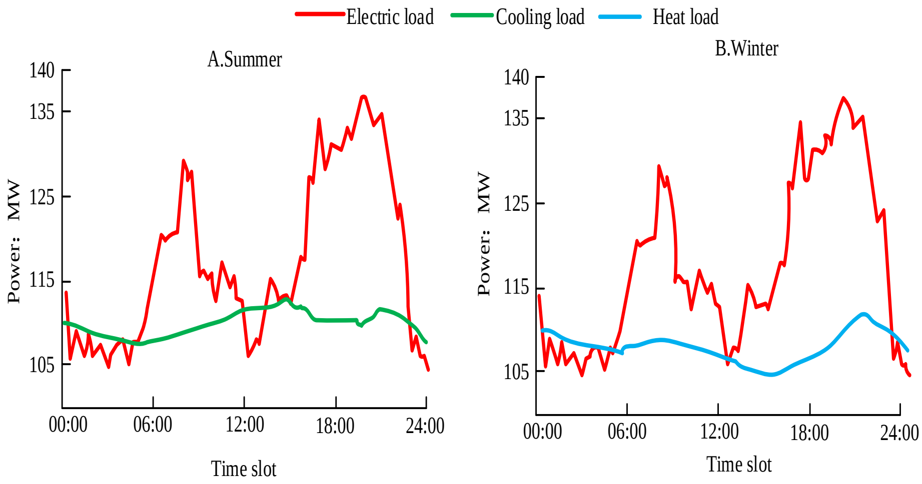

Figure 2 Case plot of summer and winter load prediction in industrial parks

Secondly, according to the climate conditions of the industrial park, the corresponding curve diagram of the fan and photovoltaic output is drawn, as shown in Figure 3.

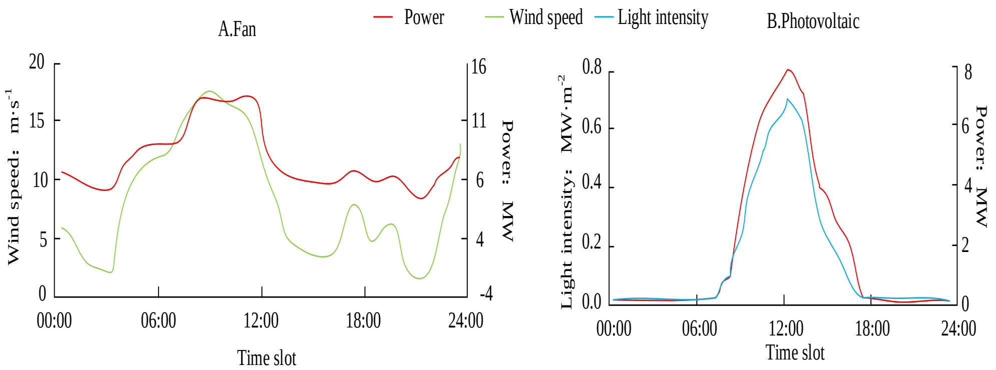

Figure 3 algorithm Case Plot of the climate fan and photovoltaic output in the industrial park

Finally, the output of each element under the improved genetic algorithm in the industrial park was analyzed in summer, as shown in Figure 4;

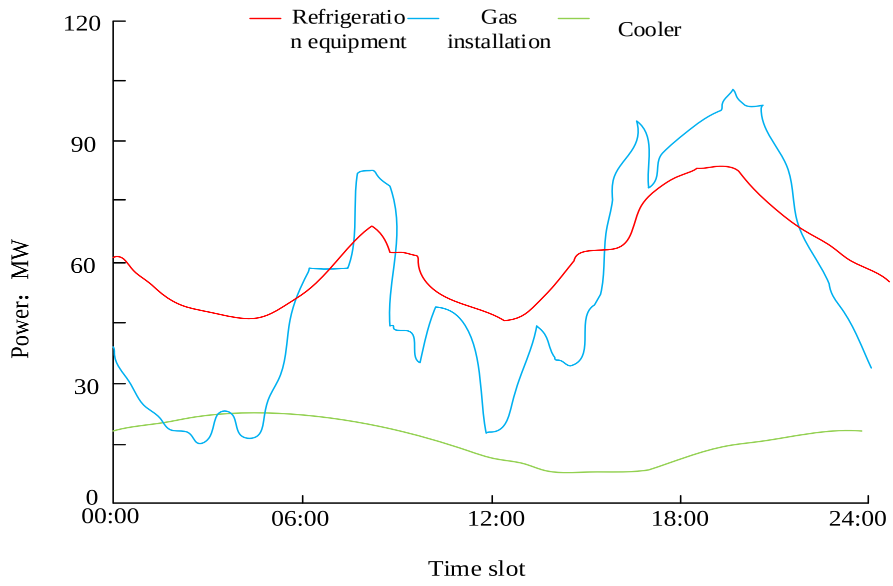

Figure 4 Output curve diagram of each element in the industrial park under the improved genetic algorithm in the summer

At the same time, the comprehensive power generation cost of the industrial park in summer is obtained according to Figure 4, as shown in Table 2.

Table 2 Price table of the comprehensive power generation cost of the industrial park in the summer

content	Cost input: yuan
CCHP	2100000
Cold machine	290000
Later equipment operation and maintenance	98000
Microgrid power trading	414000
amount to	2902000

5. Conclusion

To sum up, based on the improvement of genetic algorithm of industrial park renewable energy power transformation method research, can realize the unification of a variety of renewable energy energy management, thus effectively reduce the cost of energy system operation, at the same time the heat yuan and thermoelectric combined unit mutual cooperation, can effectively improve the operability of thermal mode, give full play to the advantages of coordination scheduling, further improve the stability of energy supply in industrial park. In addition, improved genetic algorithms can efficiently deal with the deficiencies in the process of energy management, so as to increase the level of energy management in industrial parks and implement the concept of green development.

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