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Modeling and Collaborative Optimal Operation Strategy for Port Integrated Energy System

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Abstract

The Port Integrated Energy System (PIES) is qthe solution in helping obtain a cost-effective green energy source for ports to provide all the energy demands of a port. However, the coupling of multiple energy sources increases the complexity of the system operation, so effective optimization methods are needed to ensure its operation economy. By analyzing the structure of the port integrated energy system, a practical framework of the port integrated energy system is constructed. On this basis, a collaborative optimization scheduling method for port integrated energy system is proposed. The simulation results of the case show that the collaborative optimization operation can greatly improve the economic efficiency of the port integrated energy system.

Keywords

Operation Strategy; Integrated Energy System; Port Integrated Energy System; Power.

1. Introduction

Ports are very crucial in water transportation, be it in lakes or oceans. Without ports, transportation of goods will not be possible in water bodies. Harbors, on the other hand, are the heart of port cities. Ports act as a crucial link between the periphery of water bodies and the mainland [1]. Ports are responsible for more than 90% of world trade [1]. The main reason why sea transport takes the most significant percentage of the world's business is due to its cost-effective nature in the transportation of cargo and especially raw materials [4]. Air transport is rarely used in the transportation of heavy cargo unless when perishable or during emergencies. Chen further argues that road transport, on the other hand, is not feasible due to the water bodies surrounding nations, hence making it impossible to use road transport across continents. [1]

Since most of the raw materials are transported using seaways, most manufacturing industries are situated close to the ports [1]. With industries across ports, there are increased commercial activities that require power. In addition to the need for electricity to run the operations of the port, it is good to note that ports suffer from a lot of pollution from fuel consumption through road transport and train transport since they act as peak up points for goods. The use of carbon fuels in the production of energy, therefore, increases pollution and hence the need for cleaner forms of energy in ports for heating, cooling, and electricity, among other uses. In addition to seeking cleaner types of power, the kinds of energy being aimed should be economical [1].

Integrated Energy System (IES) coordinates and optimizes different energy sources, such as electricity, gas, cooling and heating, etc., to improve primary energy efficiency through energy cascade utilization, expected to increase sustainability, reliability, efficiency, of the conventional energy system.

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To model a sustainable PIES, several renewable sources of energy are supposed to be integrated. To integrate various energy sources into one system, an Energy Hub (EH) is required due to the use of different energy carriers in the system [1]. The function of the EH is to convert the various sources of energy, store them then dispatch depending on the demand. The EH must be designed to meet all the energy needs of the port [1]. Apart from the energy requirement, one has to look for energy sources in terms of the capability of the sources [1]

If well designed, one EH can handle all sources of energy in the port ranging from wind energy, solar energy, and tidal energy, then handle all the loads of energy and even supply the electricity to the whole city. Since the port has various infrastructures that require power, the planning of the EH can be done using combined cooling and heating power (CCHP) units, GB (Gas Boiler) unit, and gas storage (GS) unit for energy storage jointly. By doing so, there is reduced power loss as compared to the traditional power systems [2]. Also, it helps in increasing the area coverage of produced electricity at a lower cost of production. EH also makes it possible for the conversion of one form of energy into another one when there is excess production of one type of energy [3]. For example, it is possible to convert excess electricity being produced in the renewable sources of energy to gas fuel by just adding power to gas (PtG) units [3].

In terms of modeling of integrated energy system, Ref. [2] carries out comprehensive modeling of regional electric power, natural gas and thermal system, gives regional energy network model, and conducts multi-energy flow optimization analysis on this basis. Ref. [3] modeled the regional integrated energy system based on electric hot and cold bus, but it did not consider the model of individual equipment. Ref. [4] establishes the nonlinear time domain model of the regional integrated energy system, but it only takes into account a few equipment such as gas turbine and gas boiler.

In terms of the optimized operation of integrated energy system, it is generally targeted at economic efficiency. Some literature takes environmental protection and carbon dioxide emissions into consideration. Ref. [5] takes the economic efficiency of co-generation of heat and power and the emission of pollutants such as nitrogen oxides into consideration, and establishes a multi-objective optimization operation model. Ref. [6] studies the low-carbon economic operation method of the regional integrated energy system including electrical heat under the carbon emission market environment. Ref. [7] comprehensively analyzed the relevant technologies to improve the wind electricity absorption capacity through large capacity heat storage from multiple perspectives. Ref. [8] studied the planning and operation optimization model of power acceptance through energy storage enhancement of photovoltaic power. In Ref. [9], electric energy storage and thermal energy storage were included simultaneously. Ref. [10] combined optimization of heat pump and hybrid energy storage to suppress wind power fluctuations. Ref. [11] proposes a two-tier optimization model based on time-of-use price, considering both the interests of buildings and electricity selling companies.

However, there are few studies on the modeling of PIES at home and abroad. The objective of this paper is to establish a framework of IPES, which aims to make the operation of the whole system the most economical, and at the same time to carry out the collaborative optimization of IPES. Based on this, this paper mainly carries out the research work from the following points.

(1) The common equipment of the port integrated energy system was modeled, and the grid and heat network constraints among multiple energy stations in the regional integrated energy system were considered, and the network model of multi-energy stations in the MW level port integrated energy system was taken into account to carry out the cooperative optimization operation of EH stations with economic performance as the objective.

(2) The port integrated energy system equivalent modeling is carried out according to the energy station, but when it comes to the optimization of controllable important equipment, the modeling and control of a single equipment is carried out to ensure the control accuracy.

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2. The modeling of port integrated energy system

2.1 EH model

The PIES will mainly use electricity and biogas in the provision of heating, cooling, and the electrical needs of the port [9]. The primary source of biogas will be obtained from biomass gasifiers. Electricity, on the other hand, will be generated from wind energy, tidal energy, and solar energy. The system will contain 2 EHs that will be interconnected, as shown below, with connections to a distribution port of biogas and electricity [11].

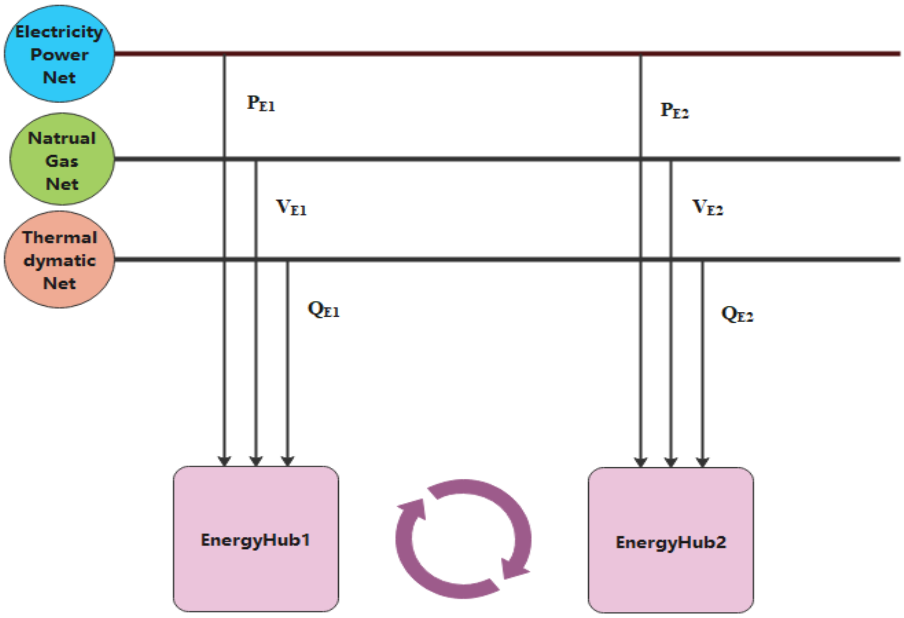

Figure 1. The energy hub model

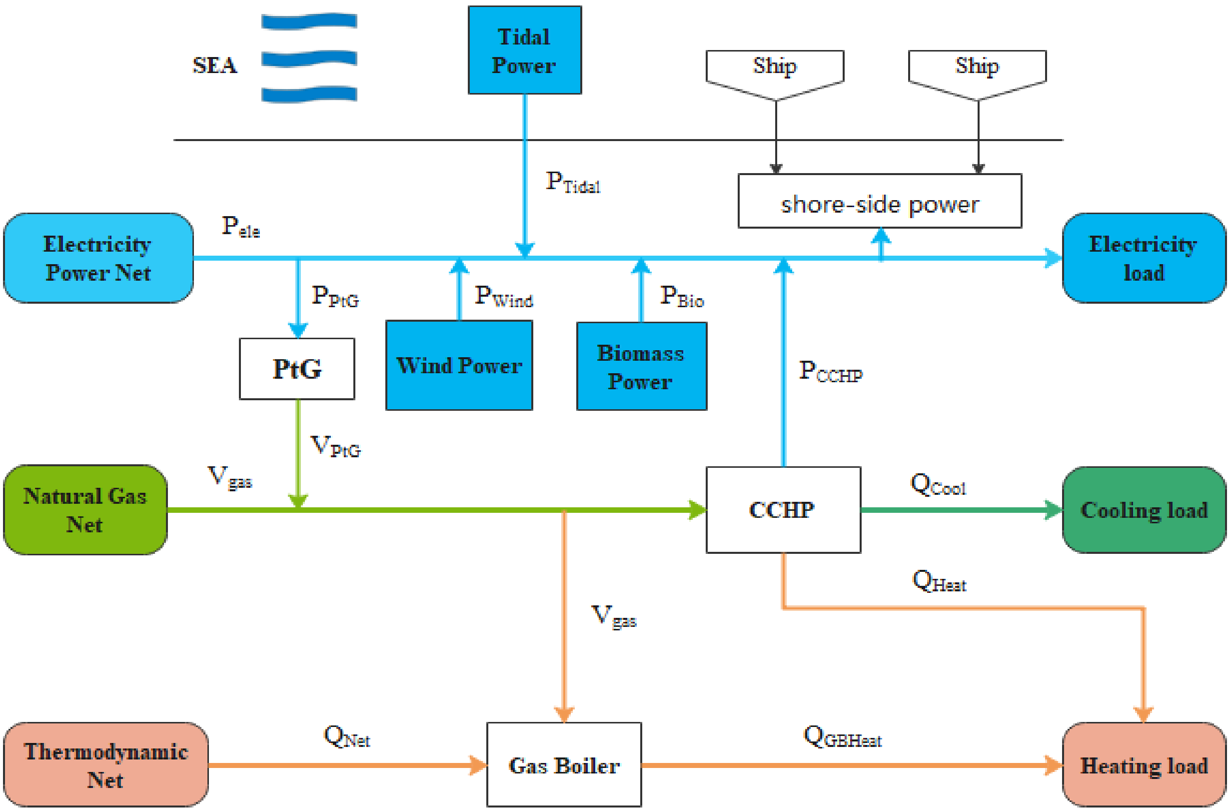

Figure 2. The Port Integrated Energy System

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2.2 Renewable energy power model

The model in Ref. [9] in this paper predicts wind power and photovoltaic power generation based on the predicted wind speed number, solar radiation intensity, environmental temperature and other data, and the detailed process will not be repeated.

2.3 CCHP unit model

As the core energy flow coupling equipment of the regional integrated energy system, THE CCHP unit relates the whole energy system through the load end of the natural gas system, the power end of the power generation system and the production end of the hot and cold energy. Its mathematical model is as follows. [12]

$$F_{CCHP}^{g}=u_{CCHP}(t)\cdot P_{CCHP}^{e}(t)\cdot\frac{1}{\eta_{CCHP}^{e}(t)}\cdot\frac{1}{LHV} \tag{1}$$

$$\eta_{CCHP}^{e}(t)=a_{CCHP}\times\left(\frac{P_{CCHP}^{e}(t)}{P_{CCHP,N}^{e}}\right)^{3}+b_{CCHP}\times\left(\frac{P_{CCHP}^{e}(t)}{P_{CCHP,N}^{e}}\right)^{2}+c_{CCHP}\times\left(\frac{P_{CCHP}^{e}(t)}{P_{CCHP,N}^{e}}\right)+d_{CCHP} \tag{2}$$

$$P_{WHB}^{h}(t)=u_{CCHP}(t)\cdot\frac{P_{CCHP}^{e}(t)}{\eta_{CCHP}^{e}(t)}\cdot(1-\eta_{CCHP}^{e}(t)-\eta_{CCHP}^{loss}) \tag{3}$$

$$P_{CCHP}^{c}(t)=u_{CCHP}(t)\cdot P_{LR}^{h}(t)\cdot\eta_{LR} \tag{4}$$

$$P_{CCHP}^{h}(t)=P_{GT}^{h}(t)-P_{LR}^{h}(t) \tag{5}$$

F_{CCHP}^{g} is the natural gas consumption of CCHP unit in time period T; $u_{CCHP}(t)$ is the start and stop state of CCHP unit in time period T,1 means starting up,0 means stopping; $P_{CCHP}^{e}(t)$ is the output electric power rate of the CCHP unit in time period T; $\eta_{CCHP}^{e}(t)$ is the power generation efficiency of CCHP unit in time period T. LHV is the low calorific value of natural gas, 9.7kwh /Nm3[12]; a_{CCHP}, b_{CCHP}, c_{CCHP}, d_{CCHP} are the coefficients of the generation efficiency of the CCHP unit are respectively. $P_{CCHP,N}^{e}$ is the rated electric power of the CCHP unit; $P_{WHB}^{h}(t)$ is the heat output power of waste heat recovery boiler in the CCHP unit in time period T. η_{CCHP}^{loss} loss CCHP is the heat energy dissipation rate of CCHP unit; $P_{CCHP}^{h}(t)$ is the heat output power of the CCHP unit in the hour T; $P_{CCHP}^{c}(t)$ is the output cooling power of the CCHP unit in time period T; $P_{LR}^{h}(t)$ is the heat power drawn from the gas turbine by the lithium bromide absorption refrigeration device (LiBr Refrigerator, LR) in time Period T; η_{LR} represents the heat and cold conversion efficiency of the LR.

2.4 Electric refrigeration equipment model

The model of electric refrigeration equipment is:

$$P_{ER}^{c}(t)=P_{ER}^{e}(t)\times COP_{ER} \tag{6}$$

$P_{ER}^{c}(t)$ is the cooling power output of the electric refrigeration equipment in time period T; $P_{ER}^{e}(t)$ is the input electric power of the electric refrigeration equipment in time period T; COP_{ER} is the energy efficiency coefficient of electric refrigeration, set as 3.2[13].

2.5 Regenerative boiler model

The model of the thermoelectric boiler is:

$$E_{TSEB}(t)=E_{TSEB}(t-1)\times(1-\sigma_{TSEB}\times\Delta t)+\left(P_{TSEB}^{e}(t)\times\eta_{TSEB}^{cha}-\frac{P_{TSEB}^{h}}{\eta_{TSEB}^{dis}}\right)\times\Delta t \tag{7}$$

$E_{TSEB}(t)$ refers to the heat stored by the accumulative electric power boiler in time period T; σ_{TSEB} is the self-heat dissipation rate of the storage thermoelectric boiler; P_{TSEB}^{e} is the electric power input to the regenerative electric boiler at time t; P_{TSEB}^{h} is the heat output power of the storage thermoelectric boiler at time T; η_{TSEB}^{cha} and η_{TSEB}^{dis} represent the charge and discharge efficiency of a thermoelectric boiler respectively.

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2.6 Gas boiler model

The gas consumption of a gas-fired boiler is related to the heat output power, and its model is:

$$F_{GB}^{g}(t)=\frac{P_{GB}^{h}(t)}{(LHV\times\eta_{GB})} \tag{8}$$

$F_{GB}^{g}(t)$ is the input gas volume of gas-fired boiler at time period T; $P_{GB}^{h}(t)$ is the heat output power of gas-fired boiler in time period T; η_{GB} refers to the gas-heat conversion efficiency coefficient of gas-fired boiler, set as 0.85[13].

2.7 Power network model

If only the active power loss of transmission line is considered when studying the electric energy transmission between EHs, and assuming that the voltage of EH is rated, then the transmission line loss between the two energy stations is

$$P_{loss}^{e}(t)=I_{12}^{2}(t)\times R_{12} \tag{9}$$

$$I_{12}(t)=\frac{P_{12}^{e}(t)}{U_N} \tag{10}$$

$P_{loss}^{e}(t)$ refers to the power transmission loss between energy hub 1 and energy hub 2 ; $I_{12}(t)$ is the power line current between energy stations; R_{12} for power line resistance between the power station; $P_{12}^{e}(t)$ is the active power of power line injected into energy hub 1; U_N refers to the rated voltage of the interstation network.

2.8 Thermal network model

In a port integrated energy system, hot water is generally used as the medium, and the heat energy is transferred from the heat source to the load thermodynamic model by means of the supply and return water pipe network. The thermal model includes two parts: the energy supply power of heat source and the power loss of hot water pipeline.

$$P_{12}^{h}(t)=c_w\cdot\rho_w\cdot\frac{G_s(t)}{3600}\cdot\left(T_{S,s}(t)-T_{S,r}(t)\right) \tag{11}$$

$$P_{Lloss}^{h}(t)=\frac{L_{12}}{R_H}\cdot\left(T_{S,s}(t)-T_a(t)\right) \tag{12}$$

$P_{12}^{h}(t)$ is the heat power injected into the heat network by the heat source;c_w is the specific heat capacity of the fluid and generally takes the value of 4.2[14]. ρ_w is the fluid density, generally valued at 1 000 kg/m3[14]; $G_s(t)$ is the return water flow of the heat source; $T_{S,s}(t)$, S, $T_{S,r}(t)$ are respectively the return water temperature of the heat source. When energy hub 1 transmits heat energy to energy hub 2, S represents energy station 1. Conversely, it stands for energy hub 2. $P_{Lloss}^{h}(t)$ is the heat loss of the pipeline; L_{12} is the length of pipe between energy stations; R_H is the total thermal resistance of 1 km pipeline between the heat medium and the surrounding medium, generally taking the value of 2.89 [14]. $T_a(t)$ is the ambient temperature of the pipeline between energy stations.

3. Cooperative optimization operation model of integrated energy system

3.1 Objective function

The cooperative optimization operation of the port integrated energy system takes economy as its target. The objective function includes fuel cost, electricity interactive cost, unit start and stop cost and equipment maintenance cost.

$$minC_{tot}=C_f+C_e+C_{st}+C_w \tag{13}$$

$$C_f=\sum_{t=1}^{T}\sum_{i=1}^{I}c_f\times F_i^g(t)\times\Delta t \tag{14}$$

$$C_e=\sum_{t=1}^{T}\left(c_{buy}^{e}(t)\times P_{buy}^{e}(t)\times\Delta t\right)-\sum_{t=1}^{T}\left(c_{sell}^{e}(t)\times P_{sell}^{e}(t)\times\Delta t\right) \tag{15}$$

$$C_{st}=\sum_{t=1}^{T}\sum_{n=1}^{N_{st}}c_{st,n}\times|U_n(t)-U_n(t-1)| \tag{16}$$

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$$C_w = \sum_{t=1}^{T}\sum_{i=1}^{I}\left(c_{w,i} \times P_i(t)\right) \tag{17}$$

C_{tot}, C_f, C_e, C_{st},C_w are respectively the total operating cost of the regional integrated energy system in a unified day, fuel cost, electricity purchase and sale, electricity cost, unit start and stop cost and equipment maintenance cost; T is the total number of hours of optimal operation in a day; c_f is the unit price of natural gas; $F_i^g(t)$ is the gas consumed by equipment J in the regional integrated energy system at time period T;J is the number of CCHP units and gas-fired boilers with natural gas as fuel input; $c_{buy}^e(t)$, $c_{sell}^e(t)$ are respectively the price of electricity purchased from electricity and the price of electricity sold to the grid by the regional integrated energy system in time period T; $P_{buy}^e(t)$, $P_{sell}^e(t)$ are the power purchased from the power grid and the power sold to the power grid by the port integrated energy system in time period T. N_{st} is the number of units in the regional integrated energy system with start-stop cost; $c_{st,n}$ is the start and stop cost of equipment N; $U_n(t)$ set the start-stop state of N for time period T, and take 0(for stop) or 1(for start); I is the number of all equipment in the regional integrated energy system; $c_{w,i}$ is the maintenance fee of equipment I; $P_i(t)$ is the output power of equipment I in time period T.

3.2 Constraints

3.2.1. Internal energy balance

The internal requirements of the two energy hubs are to meet the thermal energy and cold energy balance constraints of each self-electric energy, which are uniformly expressed as Equations (20) - (22). In the energy balance constraint equation, all the equipment of the regional integrated energy source system is listed. If the energy station does not contain any equipment, its power is set to 0.

$$\sum_{q_1=1}^{Q_{CCHP}} P_{CCHP,q_1}^e(t) + P_{WT}^e(t) + P_{PV}^e(t) + P_{buy}^e(t) + P_{ES}^{dis}(t) - P_{sell}^e(t)$$
$$-P_{ES}^{cha}(t) - P_{TSEB}^e(t) - P_{12}^e(t) - P_{ER}^e(t) = P_{load}^e(t) \tag{18}$$

$$\sum_{q_1=1}^{Q_{CCHP}} P_{CCHP,q_1}^h(t) + \sum_{q_2=1}^{Q_{GB}} P_{GB,q_2}^h(t) - P_{12}^h(t) + P_{TSEB}^h(t) - P_{HS}^{cha}(t) + P_{HS}^{dis}(t) = P_{load}^h(t) \tag{19}$$

$$\sum_{q_1=1}^{Q_{CCHP}} P_{CCHP,q_1}^c(t) + P_{ER}^c(t) - P_{CS}^{cha}(t) + P_{CS}^{dis}(t) = P_{load}^c(t) \tag{20}$$

$P_{load}^e(t)$, $P_{load}^h(t)$, $P_{load}^c(t)$, respectively is the electric heat and cooling load of the regional integrated energy system; $P_{CCHP}^e(t)$, $P_{CCHP}^h(t)$, $P_{CCHP}^c(t)$ respectively refers to the output electric heat and cooling power rate of the CCHP unit in time period T; Q_{CCHP}, Q_{GB} is the number of CCHP units and gas-fired boilers respectively; $P_{WT}^e(t)$, $P_{PV}^e(t)$ is the predicted power generation output of wind power and photovoltaic power respectively in time period T; $P_{12}^e(t)$, $P_{12}^h(t)$ refer to the electric power and thermal power transmitted from energy hub 1 to energy hub 2 in time period T respectively. When energy transmits electric power and thermal power from energy hub 2 to energy hub 1, $P_{12}^e(t)$, $P_{12}^h(t)$ is negative value.

3.2.2. Power limits

Power limits include the power constraints between the integrated energy system and the Power grid, the CCHP unit output Power constraints, power constraints between EH and the Power grid, the heat grid

$$\begin{aligned} &0 \le P_{buy}^e(t) \le P_{buy,\max}^e \\ &0 \le P_{sell}^e(t) \le P_{sell,\max}^e \\ &\left|P_{12}^e(t)\right| \le P_{12,\max}^e \\ &\left|P_{12}^h(t)\right| \le P_{12,\max}^h \\ &P_{WHB,i}^h(t) \ge P_{LR}^h(t) \end{aligned} \tag{21}$$

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$P_{buy,max}^{e}$ and $P_{sell,max}^{e}$ are respectively the maximum allowable power purchase and power sale of the connection line between the regional integrated energy system and the power grid; $P_{12,max}^{e}$ is the maximum power transmitted between energy hub 1 and energy hub 2; $P_{12,max}^{h}$ is the maximum heat transfer power between energy hub 1 and energy hub 2; $P_{WHB,i}^{h}(t)$ is the heat output of waste heat recovery boiler of CCHP unit in time period T; $P_{LR}^{h}(t)$ is the heat input power of lithium bromide absorption refrigeration of CCHP unit in time period T.

3.2.3. Other limits

Other limits contain Start and stop time constraint of CCHP unit, CCHP unit climbing rate constraint, spare capacity constraint, multiple energy storage related constraints.

$$\begin{aligned}
&\left(T_{CCHP}^{on}-T_{CCHP}^{U}\right)\left(U_{CCHP}(t-1)-U_{CCHP}(t)\right)\geq 0\\
&\left(T_{CCHP}^{off}-T_{CCHP}^{D}\right)\left(U_{CCHP}(t)-U_{CCHP}(t-1)\right)\geq 0\\
&P_{CCHP}^{down}\leq\left(P_{CCHP}^{e}(t)-P_{CCHP}^{e}(t-1)\right)\big/\Delta t\leq P_{CCHP}^{up}\\
&P_{CCHP}^{UP}(t)+P_{GRID}^{UP}(t)\geq P^{UP}\\
&P_{CCHP}^{DOWN}(t)+P_{GRID}^{DOWN}(t)\geq P^{DOWN}\\
&0\leq P_{S}^{dis}(t)\leq\gamma_{S}^{dis}\times C_{S}\\
&0\leq P_{S}^{cha}(t)\leq\gamma_{S}^{cha}\times C_{S}\\
&SOC_{s}^{\min}\leq\frac{E_{s}(t)}{C_{s}}\leq SOC_{s}^{\max}
\end{aligned}\tag{22}$$

$U_{CCHP}(t)$ refers to the start-stop state of CCHP unit in time period T; T_{CCHP}^{on} and T_{CCHP}^{off} refer to the continuous starting time and shutdown time of the CCHP unit before time period T; T_{CCHP}^{U} and T_{CCHP}^{D} are the minimum continuous startup and shutdown time required by the CCHP unit. P_{CCHP}^{down} and P_{CCHP}^{up} are respectively the maximum downhill rate and maximum uphill rate of the electrical output of the CCHP unit. $P_{CCHP}^{UP}(t)$ and $P_{CCHP}^{DOWN}(t)$ are the positive and negative rotating spare capacity provided by the CCHP unit in time period T. $P_{GRID}^{UP}(t)$ and $P_{GRID}^{DOWN}(t)$ are respectively the positive and negative rotating spare capacity provided by the power grid in time period T; P^{UP} and P^{DOWN} are the minimum rotary reserve capacity of positive and negative electric energy required by the port integrated energy system.

4. Case study\

4.1 Setting of key parameters

As a case study, Fig.1 demonstration a project as an example. The port integrated energy system can interact with the grid electricity, PV and wind power within the area and CCHP generating units first meet internal load, and sell electricity to the grid when there is surplus electricity, buy electricity from the grid when it is scarce, The price of electricity purchase and sale shall be based on the peak and valley electricity price of the city , peak period (9:00 ~ 15:00, 18:00 ~22:00) purchase and sale of electricity at the price of 0.83 yuan/kWh and 0.65 yuan/kWh. At ordinary times, the electricity prices of the section (7:00~9:00, 15:00~18:00 and 22:00~23:00) is 0.49 yuan /kWh and 0.38 yuan /kWh, and the electricity price of purchase and sale in the valley period (0:00~7:00, 23:00~24:00) is 0.17 yuan /kWh and 0.13 yuan /kWh. The port integrated energy system is connected to the urban natural gas system and buys natural gas from the natural gas company at a price of 2.5 yuan /m^3.

The forecast data of PIES load and renewable energy output are shown in Figure 3, in which the load of energy hub 1 is mainly residential load, while the load of energy hub 2 is mainly port commercial load. The parameters of the energy storage equipment in the PIES are shown in Table 1 [12], and the operating parameters of other major equipment are shown in Table 2. In this paper, the nonlinear

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model established above is processed by the linearization method proposed in Ref [15], and the CPLEX solver is used to calculate in MATLAB platform.

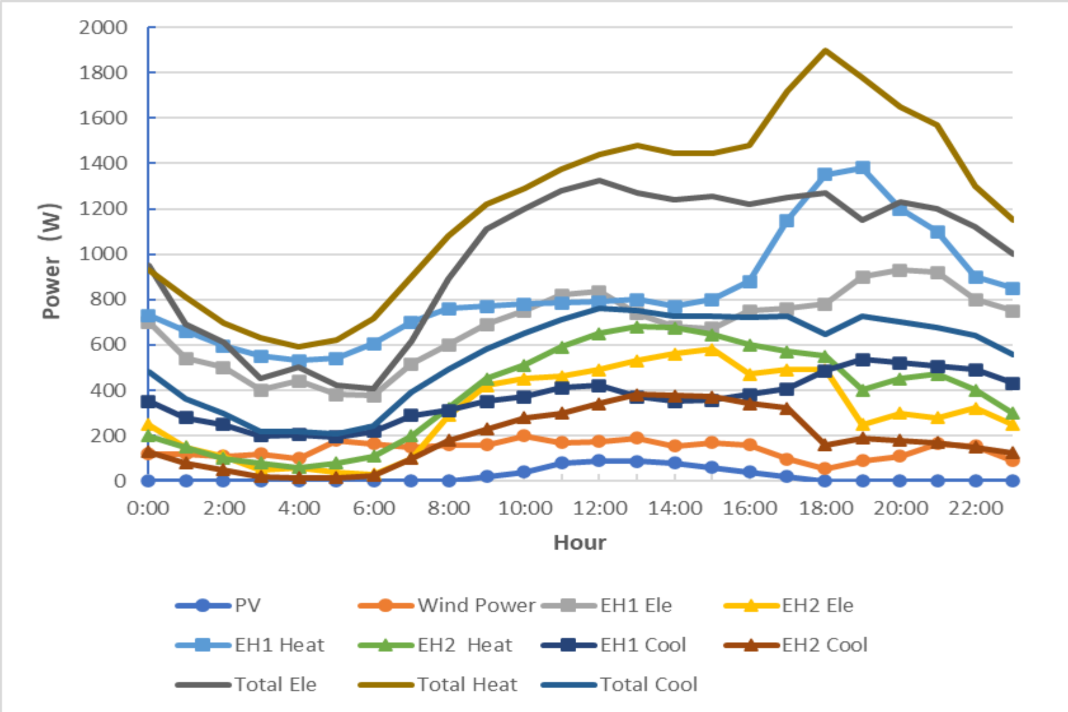

Figure 3. PIES load and predicted renewable energy output

Table 1. Parameters of energy storage equipment

	ES	HS	CS	TSEB
η_s^{cha}	0.90	0.95	0.95	0.95
η_s^{dis}	0.90	0.95	0.95	0.95
σ_s	0.001	0.010	0.010	0.010
γ_s^{cha}	0.2	0.2	0.2	0.2
γ_s^{dis}	0.2	0.2	0.2	0.2
$E_S(0)$	400	200	200	200
C_s	2000	1000	1000	1000
c_w	0.02	0.01	0.01	0.01

Table 2. Parameters of other main equipment

	GB	GT	TSEB	ER	LR
Rated power of equipment P^{max}/kW	200	500	100	100	300
Equipment maintenance cost $c_w/(Yuan \cdot kW^{-1})$	0.012	0.100	0.006	0.015	0.020

4.2 Analysis of results

To verify the multi-energy hub association of PIES proposed in this paper. With the economy of the optimized operation method, three operation modes are set Mode 1: Collaborative optimization operation of two energy hubs mentioned in this paper; Mode 2: The two energy hubs in the energy system have no heat network and power grid interconnection, respectively, independent and optimized operation of energy hub; Mode 3: the traditional electric heating and cooling alone. Instant supply mode operation, the electricity needed by the grid directly supply, thermal energy. Through the gas boiler supply, cold energy through the air conditioning refrigeration supply. In order to make. The three modes are more comparable. The electrical load of Mode 3 has been removed. Net load

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after wind and light renewable energy generation power. Three kinds of operation. The costs of the method are shown in figure 3.

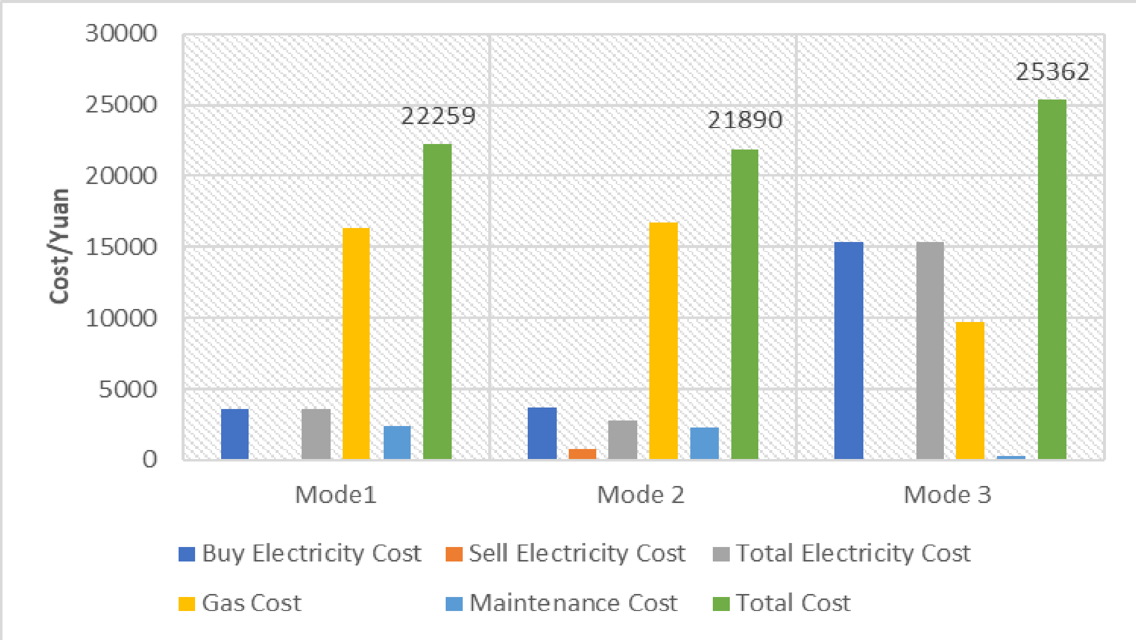

Figure 4. Comparison on operation costs of three operation modes

It can be seen from Table 3 that the cost of traditional energy supply Mode 3 is the highest, and the economy of mode 1 is 12.2% higher than that of Mode 3. Compare Mode1 with Mod2. Economy increased by 1.6%. In Mode 3, electricity purchase cost is the largest, accounting for 60.5% of the total operating cost. In Mode 1, the gas cost is the highest, accounting for 73.2% of the total operating cost, while the electricity purchase cost only accounts for 16.0%. This indicates that the CCHP unit can carry out hierarchical utilization of energy and has incomparable high energy efficiency in the field of multi-energy consumption terminals.

5. Conclusion

Firstly, this paper researches the internal structure of port integrated energy system and establishes the key equipment model of port integrated energy system. Considering the electrical energy, thermal energy and natural gas, a interaction energy hub is established. Between the practical model of electric power network and network based on this, advances the system to run economy as the goal of port integrated energy system power station more collaborative optimization operation strategy is verified by case simulation can source station collaborative optimization running of the economic efficiency of terminal power can be greatly improved.

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