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Energy Conversion Efficiency in Cloud Computing Environment

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Abstract: With the requirements of large-scale computing and green concepts, cloud computing(CC) has become a hot topic. As one of the key problems in CC, energy conversion efficiency(ECE) has also received more and more optimized solutions from all angles under the attention of many scholars. This paper studies the ECE in CC environment, introduces the basic theory and related knowledge of CC, as well as the whole concept and framework of CC, discusses the ECE analysis theory based on CC environment, and analyzes the algorithm of energy conversion under CC technology. On this basis, the conversion efficiency is analyzed and studied, and good results are achieved.

1. Introduction

With the adjustment of China's energy structure, the demand for natural gas is increasing, and the proportion of sustainable energy in the energy structure is increasing. The shortage of natural gas and the serious phenomenon of abandoning wind and light have hindered the adjustment of China's energy structure. CC contains a wealth of technologies, in which computer resources are usually clusters composed of computers in different geographical locations, and PTG technology is one of them; PTG technology converts waste wind power and photoelectric into methane, which is not only conducive to the storage and transmission of energy, but also can make rational use of waste wind power and photoelectric, so as to fundamentally solve the relatively serious problem of wind and light abandonment in China. This paper studies the ECE in CC, improves the performance of resource allocation and saves efficiency, which has important academic value,

Many scholars at home and abroad have analyzed the research on ECE in CC environment. Shahid Ma et al. Discussed a major problem of cloud environment, namely load balancing (LB). The goal of LB is to balance the computing on ECs to ensure that there is no shortage / overload of hosts. Provide effective management and meet customers' requests for appropriate cloud nodes, improve the overall efficiency of cloud services, and provide higher satisfaction for end users. Efficient LB algorithm improves efficiency and asset utilization by effectively distributing the workload on different nodes of the system [1]. Boudi a et al. Realized the above concept by providing a unified layered closed-loop network and service management framework that can meet the expected goals. We propose a cloud native simulator, which can accurately simulate the cloud native environment and enable us to quickly evaluate new frameworks and ideas. The simulation results prove the efficiency of our simulator to simulate the real test bed under various indicators [2].

The huge computing and storage capacity of CC provides various services for enterprises and users. CC is one of the trends of computer technology in the future. With the popularization and application of CC, CC is in the process of rapid development, which brings huge energy consumption to the data center. In particular, the infrastructure of CC data center is usually composed of tens of thousands of computers, which increases a lot of energy consumption. In this paper, it will be of great significance for the development of new energy to study the conversion efficiency in the CC environment by using streaming. In this paper, PTG technology and gas-fired power generation technology are combined to transform the waste sustainable energy power generation into natural gas storage and transportation. It realizes the energy interconnection of gas, electricity and heat energy, and converts electricity into gas, which is suitable for large-scale and large-scale energy storage, and solves the problem of large-scale storage of electricity [3-4].

2. Research on ECE in CC Environment

2.1. CC Environment

At present, the service level of CC can be divided into three levels: software as a service refers to that users can order and use various software through the browser, and these software are deployed on the server by SaaS service providers in advance. Users only need to pay according to the number of software and use time [5]. Platform as a service (PAAS) provides developers with a complete set of software and hardware resources required for software development. After users develop their own applications on the customized PAAS platform, they can transfer the applications to the corresponding customers through the Internet. Infrastructure as a service can provide users with various virtual hardware resources (host, network, storage, etc.), and users can build their own operating system by renting it on demand. The service level of CC is shown in Figure 1.

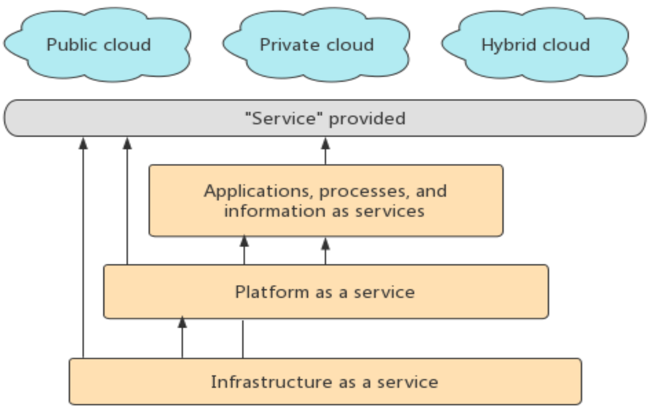

Figure 1. Cloud computing service level

CC contains a wealth of technologies. To sum up, it mainly includes the following key technologies: virtualization, resource management and scheduling, file system, data storage, cloud security, programming mode, energy consumption management. At present, virtualization technology can virtualize CPU, OS, server, etc. virtualization technology is also one of the best ways to improve service efficiency.

Virtualization technology is an important cornerstone to support CC. Virtualization software abstracts hardware resources, which makes it easy to schedule and manage resources and isolate virtual machines. The energy conversion studied in this paper is also based on virtualization technology. After using virtualization technology to virtualize the CC data center, the following four benefits can be obtained:

Integration and standardization of various resources in the data center; Re integrate the data center resources to maximize the use of hardware resources; Energy saving: shut down idle physical nodes by means of migration, and finally reduce system energy consumption; Dynamically migrate virtual machines and optimize system load [6-7].

For CC data centers, resources are large in scale and quantity. At this time, it is necessary to analyze, measure and adjust these resources reasonably and effectively before they can be used normally. When considering the scheduling problem of CC, there are generally two solutions. One is to increase the number of available resources. In terms of disaster recovery backup of data, most CC file systems adopt the method of redundant backup, that is, storing multiple copies of the same data, which ensures that the CC system can use low configuration computers to replace high-performance computers to ensure its low cost [8-9].

CC needs to process and analyze massive data when running, so it is of great significance to study the management of these data. The frequency of data read operation of CC is much higher than that of write operation. Therefore, the data storage and management technology of CC system mainly adopts column storage.

Computer resources in CC are usually clusters of computers in different geographical locations, and different computers may be heterogeneous, including differences in bandwidth, CPU, storage and so on. Virtual resource scheduling plays a very important role in CC. When scheduling user requests, user requests are first distributed to virtual hosts rather than to actual physical hosts. These virtual machines are virtualized from physical hosts through virtualization technology and do not interfere with each other. Therefore, the problem of CC physical resource scheduling has become a virtual resource scheduling problem [10-11].

2.2. ECE Analysis Theory based on CC Environment

In energy analysis, a state quantity is often used to express the energy in an object value refers to the maximum value made by the substance after it reaches stability through heat exchange with the external environment at the initial stage without heat exchange with the environment. The maximum value of this useful work is the value of the substance in the initial stage [12]. This is the thermodynamic definition of value. In the mutual conversion of various energies in the energy system, according to the law of conservation of energy, the total energy in the system remains unchanged. However, because of the second law of thermodynamics, the sum of energy in the system is reduced, which leads to the problems of loss and efficiency.

In the energy Internet system, heat, electricity, chemical energy and other energy are converted to each other. Using CC analysis can effectively solve the problems of energy loss and efficiency in the energy Internet system, improve energy utilization and reduce energy consumption. The calculation of energy loss by calorific value can only calculate the energy loss when energy is converted to each other, and the lack of energy can not express the problem of energy quality transformation in the process of energy conversion. Analyze the energy Internet, and analyze the chemical and physical changes of the system through thermochemical equations and heat exchange [13-14]. Analyzing the value of the whole system can also analyze a certain part, find out the part with the lowest efficiency, strengthen it, and seek the most efficient energy-saving scheme.

The first law of thermodynamics reflects the conservation of energy, while the second law of thermodynamics indicates that the process of energy conversion will be accompanied by energy loss and quality change. Take the energy Internet as an example. When electricity produces gas, it is converted into chemical energy, and when gas generates electricity, chemical energy is converted into electric energy [15]. There will be a gap in the efficiency of the two transformations, which means that the quality of energy is different. Today's research shows that the most advanced energy has the highest quality. In many calculation of value, electric energy is taken as the standard of value. In the process of energy conversion, both the number of energy and the quality of energy should be calculated. In the research of a large number of papers, the energy value and energy quality need to be considered when calculating the efficiency, and the utilization rate of the value should be reflected [16].

In the process of energy conversion, when reaching a stable state, the part that has no loss in the ideal state becomes value. However, energy is an irreversible process, and there are differences in energy quality, so is used to represent energy quality. By establishing the mechanism model in the energy Internet system, the mechanism model is analyzed. Establish the equilibrium equation, obtain the value of reactants and the value of products, and calculate the efficiency of the system. Put forward improvement methods according to the calculation.

The flow efficiency in the CC environment reflects the thermal integrity of the thermal system. It is a kind of specific energy efficiency analysis, which is a more reasonable evaluation index for specific energy efficiency analysis. A reasonable definition of the conversion efficiency based on CC is conducive to comparing the technical development level of various technologies, which is more reasonable than the traditional thermal efficiency analysis method, and can accurately analyze the weak links of certain types of equipment [17-18].

3. Energy Conversion under CC Technology

The efficiency analysis of energy problem belongs to the evaluation index problem of thermodynamic analysis. Among the thermodynamic evaluation indexes, there are energy utilization rate, flow analysis, etc. The energy utilization rate is based on the first law of thermodynamics, namely the law of conservation of energy, which reflects the ECE in a system, but cannot reflect the quality of energy (different types of energy, such as heat energy, electric energy and chemical energy, have different conversion rates when they are converted to each other). In the CC environment, the flow analysis is based on the second law of thermodynamics, which reflects the quality of energy. Adding flow analysis to the analysis of energy utilization can reflect both the rate of energy exchange and the quality of energy.

When analyzing the problems of energy utilization and economic cost in this system, the flow value can be taken as the index of energy utilization efficiency and economic analysis of the system. PTG technology includes electrolytic water and methane curing system. Based on the PTG technology in the CC environment, the flow analysis can obtain the maximum useful work of the system, calculate the energy input to the system, output the energy of the system, and calculate the efficiency of the system through the ratio of input to output. To calculate the input and output of the energy of the whole system, according to the thermodynamics, chemistry and power knowledge, we need to get the values of mass, temperature, pressure, voltage, current, However, the mass of fluid and gas in the pipeline is not easy to measure. The mass is converted into volume flow, and the value is obtained through the flowmeter. As shown in Figure 2, the flow value analysis of the whole system includes physical process analysis and chemical process analysis. Physical process of gas:

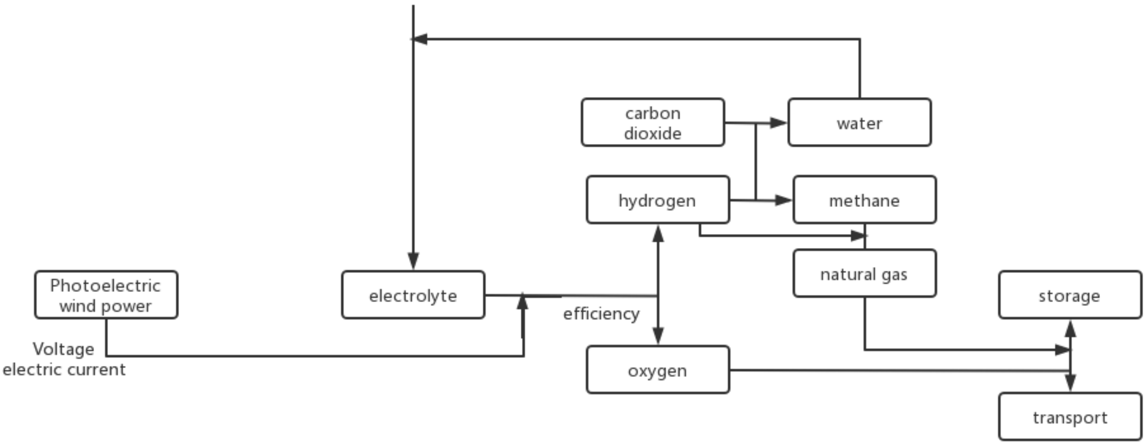

Figure 2. PTG technology mechanism model

Physical process of gas:

$$\frac{p_n v_n}{R_n} = \frac{p_0 v_0}{R_0} \tag{1}$$

$$v_0 = \frac{p_n V_n R_0}{R_n p_0} \tag{2}$$

Because the density calculation condition is that under normal temperature and pressure, through this formula, the gas volume VN of a certain temperature TN and pressure PN in the pipeline is transformed into the gas volume V0 under normal temperature R0 and pressure P0, and GN is the volume flow.the pressure and temperature subscript n is the reactant or product, for example, P1 is the pressure of water in electrolytic water, R1 is the temperature of water in electrolytic water.

$$h_n = \rho_n v_0 = \rho_n \frac{p_n R_0}{R_n p_0} g_n t \tag{3}$$

$$g_n = \sqrt{\Delta p_n / (\rho_n f S_n L_n)}, \Delta p = p_n - p_n' \tag{4}$$

Ln is the pipe length, Δ PN is the pressure difference at both ends of the pipe, ρ N is the density of the liquid, f is the acceleration of gravity, and Sn is the friction of the pipe.

Physical change process:

$$p_{n1} = c_n h_n \Delta R / r = c_n \sqrt{\Delta p_n \rho_n / (f S_n L_n)} \Delta R \tag{5}$$

chemical reaction process:

$$P_{n2} = \Delta K_n h_n / (rH) = \Delta K_n \frac{p_n R_0}{R_n p_0} \sqrt{\Delta p_n \rho_n / (fS_n L_n)} / H_n \tag{6}$$

PN is the exothermic power of chemical reaction, Δ Kn is the enthalpy of different stages, Δ KK2 is the enthalpy of electrolytic water, Δ Hmethanation1 is the enthalpy of the main reaction of methanation, Δ Hch4 is the enthalpy of full combustion of methane, and kn is the molar mass of reaction products in different stages, Δ R is the temperature change before and after the reaction, and cn is the specific heat capacity of the reaction product.

Power input:

$$P_{input} = U_n I_n \tag{7}$$

Through the temperature sensor, pressure sensor, voltage sensor and current sensor pair, obtain the temperature RN, pressure PN, voltage UN and current in the subsystem of the system as shown in the figure, obtain the power thermal reaction power PN and electric power Pinput, and calculate the actual current value by calculating the power ratio.

4. Analysis of Conversion Efficiency in CC Environment

Gas power generation technology can be divided into gas turbine power generation and gas internal combustion engine power generation, each of which can form a triple supply system. It provides thermal energy and refrigeration while providing electric energy, and makes gradient utilization of energy, which increases the ECE.

4.1. Gas Turbine

The gas turbine first heats the gas and turns the turbine through high-energy gas, converting internal energy into mechanical energy in this process. Compressor, turbine and combustion chamber are the main components and corresponding accessory systems of gas turbine. After the gas turbine runs, it will reach the energy cycle balance state after a period of time. The compressor pressurizes and processes the inhaled air through continuous operation, and sends these air into the combustion chamber, which is transformed from electric energy to kinetic energy and then to internal energy. High temperature air and gas are mixed to form high temperature gas. High temperature gas can accelerate the reaction speed and make the gas fully burn to release a large amount of energy. Then the high-temperature gas enters the combustion chamber for combustion. The chemical energy of high-temperature gas is converted into heat energy and kinetic energy, with the increase of temperature and pressure in the combustion chamber. The heated and pressurized gas enters the turbine device, and the rotating blades convert kinetic energy and heat energy into mechanical energy of the turbine unit.

Part of the energy of the gas turbine drives the compressor, which converts mechanical energy into electrical energy through Ferrari electromagnetic induction. The air is mixed with the injected gas through the compressor to form high-temperature gas, which enters the gas turbine and expands in the gas turbine to do work. On the one hand, it is converted into electric energy in the generator set; on the other hand, another part is transmitted to the outside through the heat exchanger in the form of flue gas and hot water, while the system generates electricity. Table 1 shows the performance parameters of gas turbine combined cycle units of four enterprises.

Table 1. Performance parameters of gas turbine combined cycle unit

Performance parameter	Sienems company GUDIS.94.3A	GE company S109FA	Alstom KA26-1	Mitsubishi MPCP1(701F)
Total generating power/MW	380.0	390.8	393.8	397.7
Net heat rate/(KW.h)-1	6270	6350	6154	6317
Power supply efficiency/%	58.0	56.7	58.5	57.0
Frequency/Hz	50	50	50	50
Gas turbine power/MW	255.0	254.1	257	266.1
Turbine power/MW	130	141.8	140	131.6
Gas turbine pressure	0.5098	0.558	0.5447	0.494.5
Natural gas consumption/$m3^{-1}$	4.7*108	4.9*108	4.8*108	4.9*108

4.2. Gas Engine

The internal combustion engine converts the chemical energy in the gas into kinetic energy by doing work through thermal energy. Internal combustion engines are mainly piston internal combustion engines, including reciprocating piston internal combustion engines and rotary internal combustion engines, of which reciprocating piston internal combustion engines account for the main part. The chemical energy is converted into mechanical energy, and the burned gas does work on the piston connected with the crank and connecting rod. Compared with diesel and gasoline engines, gas-fired internal combustion engines have higher power generation efficiency, ranging from 27% to 40%, and most internal combustion engines generate about 34% of power. The technology development of gas internal combustion engine has been very mature. Although the power generation efficiency is not as high as that of gas turbine, it is modular and cheap.

As shown in Figure 3, the mixture of gas and air enters the internal combustion engine, burns and expands in the internal combustion engine to do work, drives the piston to convert mechanical energy, and converts mechanical energy into electrical energy. The other part passes through the heat exchanger in the form of flue gas and hot water, and outputs hot water and cold water to the outside while the system sends out electrical force. Most gas-fired internal combustion engines generate about 420 to 490 degrees of smoke and 90 to 110 degrees of cooling water, which plays a key role in the cooling of cylinders and other components. The energy taken away by cooling water in gas-fired internal combustion engine is about 35% of gas energy. Whether it is flue gas or cooling water, the energy contained in it can be converted into hot water or cold water through an exchanger to provide it to nearby residents.

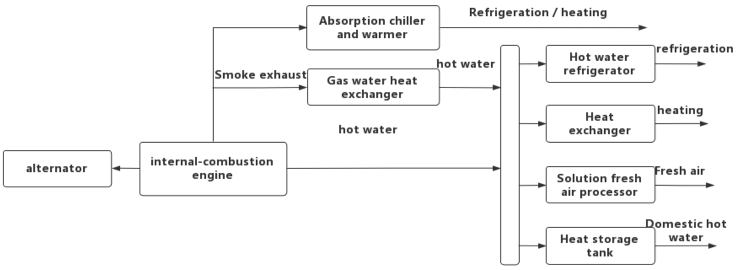

Figure 3. Basic composition of natural gas distributed energy system of internal combustion engine

4.3.Fuel Cell

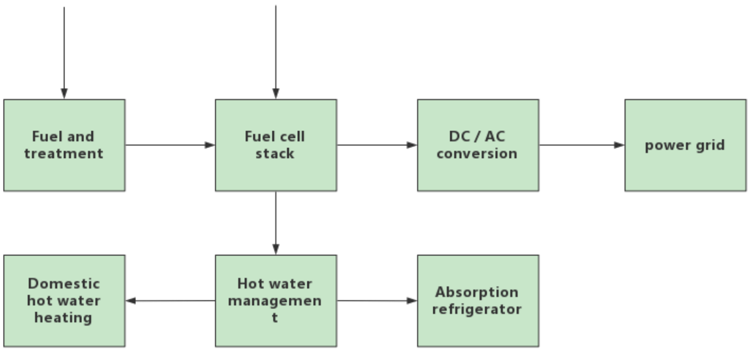

Figure 4. Basic composition of fuel cell distributed energy system

In the electrochemical reaction of the whole fuel cell, different from the traditional thermochemical power generation, the power of electrochemical power generation is higher than that of thermochemical power generation. There will be a lot of heat loss in thermochemical reaction, but there is only a small amount of circuit heat loss in electrochemistry. When gas is used as the reactant of fuel cell, the fuel pole has higher requirements for the activity of catalyst than ordinary raw materials. The fuel electrode and air electrode adopt porous structure, so that the reaction products can be discharged from the reaction tank. In order to prevent internal gas mixing, most of the reaction tanks adopt dense structure.

5. Conclusion

Based on the understanding of relevant algorithms of CC technology, aiming at the goal of improving ECE, this paper proposes a new virtual machine initial allocation algorithm, and uses language tools to simulate, which proves that the new algorithm has better energy conversion effect than some existing algorithms. The electric gas technology in the energy Internet not only realizes large-scale energy storage, but also solves the serious problem of wind and light abandonment in China. As the main energy, CC technology has promoted the development of new energy. However, CC technology in China is still in its infancy, and there is a gap compared with Germany and other Western European countries. The energy conversion in CC environment still needs to be constantly developed. As the main development direction of contemporary energy, energy Internet combines power, gas, heat and other energy to improve energy utilization and energy complementarity. In the coming period, the ECE in CC will be a problem worth studying.

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Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

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