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Analysis of Capacity Adaptability of Global Coal Terminals

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ABSTRACT. *With the continuous development of global economy and trade, global energy demand and energy structure are also constantly developing. Among them, coal plays an important role in energy supply, but the proportion in the energy structure has shown a structural decline. Coal terminal is an important part of the global coal transportation network, and its supply and demand situation also change with the evolution of the coal market. This paper adopts the concept of terminal fitness, combines the data of major coal import and export areas around the world, and displays the current distribution and supply and demand of global coal terminals. Finally, discusses the transformation direction of coal terminals.*

KEYWORDS: *coal, coal terminal, adaptability, transformation*

1. Introduction

Since the industrial revolution, coal has been widely used in many areas such as transportation, thermal power generation and coal chemical industry. It has experienced the prosperity of coal market caused by the climax of industrial construction in Europe, the United States and China, and plays a very important role in social development. Due to the uneven distribution of coal production and consumption, coal trade and transportation demand came into being, and also promoted the construction and development of coal terminals. As an important part of the global coal transportation network, the coal terminal has greatly improved its efficiency by deploying advanced and specialized equipment, but it also leads to its vulnerability to market changes. As the growth in demand for coal slows, coal terminals in various regions will be impacted to varying degrees. Therefore, grasping market changes and rational transformation and upgrading has become a matter of great consideration for coal terminal operators.

At present, researchers mainly use the concept of terminal adaptability to describe the supply and demand situation of the terminal, and it can be calculated as

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the ratio of terminal throughput capacity to actual throughput. Built on the analysis of the influencing factors of coal consumption demand in Guangdong Province and Port of Ningbo-Zhoushan, Reference [1] [2] calculates the adaptability of coal terminals in the two places and predicts the demand gap in 2015 and 2020. In Reference [3], the terminal adaptability is combined with the concept of the port construction occasion, and a method for predicting the demand for terminal throughput capacity based on the selected type of port construction occasion is proposed. These papers show that the concept of adaptability can clearly show the supply and demand of the terminal. Therefore, this paper will use this concept, and combines the data of major coal import and export areas around the world, displays the current distribution and supply and demand of global coal terminals. Finally, discusses the transformation direction of coal terminals.

2. Background

2.1 Global coal markets

Coal is the world's most abundant fossil energy source and one of the most critical basic energy sources in the world. Its status is difficult to replace in a short time. However, as a carbon-intensive energy source, the use of coal has traditionally been a hot topic in energy and climate policy debates. The widespread use of coal emits abundant of greenhouse gases such as dust and carbon dioxide has seriously polluted the environment and is a major cause of global climate change. Therefore, the coal market is vulnerable to the turmoil caused by environmental protection policies of various countries. In particular, the policy attitudes of China and India will determine the tendency of the coal market.

According to the Energy Report released by the International Energy Agency (IEA) [4], "Coal 2018 - Analysis and forecasts to 2023", global coal demand is expected to grow again in 2018 due to increased global economic growth and increased industrial output and electricity consumption. But the strong growth in India and Southeast Asia was offset by the decline in Europe and North America, so global coal demand is expected to remain stable for the next five years.

At the same time, under the trend of de-coalization of the global power industry [5] and the rapid development of new energy technologies and policies, the stagnation trend of coal demand growth has become relatively obvious. In the future, coal demand will have a certain degree of decline, and the proportion of the energy structure is also declining. The McKinsey report "Global Energy Perspective 2018"[6] states that global coal demand will peak in 2028 and then enter a phase of gradual decline. And Bloomberg New Energy Finance's New Energy Outlook report [7] pointed out that by 2050, 64% of the world's electricity generation will come from renewable energy (wind, solar, hydrogen), coal-to-power generation it will drop from 38% today to 11%.

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2.2 Distribution characteristics of global coal terminals

Due to the imbalance of coal resource distribution and the different energy needs of the country at different stages of development, it is often necessary to conduct coal trading and transportation on a global scale, and this transportation demand is mainly based on shipping and has strong directivity and concentration. As an important part of the global coal transportation network, the coal terminal is affected by the characteristics of coal transportation, mainly distributes in China, Australia, India, South Africa, Indonesia and other major coal import and export areas. As the import and export demand and equipment of different regions are different, coal terminals can be classified into coal import terminals and outport terminals.

Coal export terminals are mainly distributed in areas with abundant coal resources such as Australia, southern Africa, northern China, Indonesia and Colombia. Due to the scale economies effect of export shipments, coal export terminals are more concentrated and usually have larger scales.

Table 1 Distribution characteristics of the world's major coal export terminals

Area/Country	Distribution Characteristics	Main Port
Australia	Mainly distributed in the East Coast of Queensland and South Wales	Port of Newcastle, Hay Point and Gladstone
Indonesia	Wide distribution, large coal terminals are mainly located in the eastern and southern coast of Kalimantan Island, and southern Sumatra; Barge shipments also account for a portion of coal exports	Coal terminals of Tanjung Bara, Balikpapan, and Tarahan
In Northern China	Concentrated in the Bohai region, forming a coal export port system with Qinhuangdao Port, Tangshan Port, Tianjin Port and Huanghua Port as the four major hub ports.	Port of Qinhuangdao, Tangshan, Tianjin and Huanghua
In Southern Africa	Mainly distributed in Mozambique and the East Coast region of South Africa	South Africa: Richards Bay Coal Terminal, Port of East London Mozambique: Nacala port, Beira port
Colombia	Mainly distributed on the southern coast of the Caribbean	Puerto Drummond coal port, Puerto Bolivar coal export terminal
The United States	Mainly distributed on the East Coast and the Gulf Coast, with a small portion located in the Great Lakes and California	Port of Norfolk, Baltimore, New Orleans

Coal import terminals are matched with coal demand and are usually small in scale, and are located in demanding regions such as Europe, China, India, Japan and South Korea. With the deduction of the trend of de-coalization in the global power industry, coal import terminals such as Western Europe are taking the lead in phasing out.

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Table 2 Distribution characteristics of the world's major coal import terminals

Area/Country	Distribution Characteristics	Main Port
Europe	Located in the northwest coast of the European continent and is mainly distributed along the western Atlantic coast and the east-west corridor	Port of Rotterdam, Antwerp, Hamburg
China	Widely distributed, the entire coastal area is surrounded by nearly 70 coal import ports, which constitute a transit network for imported coal	Port of Fangcheng, Guangzhou, Xiamen, Ningbo - Zhoushan, Zhangjiagang, Rizhao, Jingtang
India	About 30 major coal import ports are located in the east and west coasts, including 12 large state-owned ports.	Mundra Port, Krishnapatnam Port, Kandla port, Paradip Port
Japan	Widely distributed, two coal import base ports have been designated and will be built as large port to receive large international ships.	Onahama Port, Port of UBE and Tokuyama-Kudamatsu
South Korea	Both the east and west coasts are distributed. The southern Gwangyang Port is the largest coal import port, and Pohang and Incheon also have large imports.	Port of KwangYang, Pohang, Inchon

3. Analysis of coal terminal adaptability

Table 3 Classification of coal terminal adaptability

Type	Adaptability	Description	Type Area
Shortage	(-1.0)	The terminal has insufficient capacity to meet the strong demand for coal import and export in the region.	Developing countries that have just started construction/Resource-based countries that have just begun to export resources, typical regions such as India and other Asian countries such as Vietnam, Thailand
Adaptive	(1.0-1.1)	The terminal has sufficient capacity to meet the import and export needs, but the ability to respond to emergencies is insufficient.	Developing countries with rising periods, typical regions such as South Africa, Indonesia
Excess	(1.1-1.3)	The terminal has a moderately advanced capacity to respond to emergencies such as ensure transportation safety and meet with peak demand.	Stablely developing countries, typical regions such as China, Japan and South Korea
Redundant	(1.3-)	The terminal has excess capacity, some terminal operations badly and lead to poor economic returns, ultimately abandoned or transformed	Countries in the late stages of industrial climax or under the influence of environmental protection policies, typical regions such as Australia, the United States, and Europe

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The cities or countries where the coal terminals are located will adopt different energy policies at different stages, so that the supply and demand situation of the coal terminals will also show different states. In order to describe the supply and demand status of coal terminals in a certain area in an accurate manner, it can be divided into four types: shortage, adaptive, excess and redundant.

The shortage type is represented by India. Although India's development of renewable energy is compelling, it can not be able to meet a large amount of energy consumption required for the electrification process in the short term. Therefore, coal import demand will continue to increase at a high rate in the short term. Compared with the demand, the supply capacity of India's coal import terminals and supporting railway collection and distribution facilities are insufficient, which is in full swing. Other emerging countries in Asia such as Thailand, Vietnam, Bangladesh, and Pakistan are is also shortage type, but these countries may pay more attention to the development of renewable energy due to their late energy demand peak.

The adaptive type is represented by South Africa. South Africa is a major coal exporter in the world. The government attaches great importance to the construction of coal port. As the Richards Bay Coal Terminal completes equipment renewal and the Coal Terminal in Ngqura Port is about to start production in 2020, south Africa has abundant coal terminal supply. At the same time, as coal demand in Africa begins to grow, the South African government forecasts that coal exports will remain basically stable in the future, and there will be no more large scale coal terminal construction in the short term.

The excess type is represented by Japan and South Korea. The coal supply in Japan and South Korea has been achieved through imports for a long time. Under the promotion of demand and the government's planning, a relatively complete coal port network has been established. To complete the Paris Agreement 2030 target, the measure of reducing the thermal power and develop renewable energy has been proposed in the two countries. Thus, the current and planned coal terminal capacity can meet the current and future coal import demand.

The redundant type is represented by Australia. Coal exports are a major source of income for Australia, so the Australian government has always been extremely concerned about the construction of coal terminal. However, as the growth rate of coal demand to be flat, the supply and demand relationship of coal terminal in Australia has been transformed from an excess type into a redundant type. A large number of construction and expansion projects have been shelved, and some of the terminals in operation have lower utilization rates.

4. Suggestions for the transformation and development of coal terminals

Under the changes in the supply and demand of the terminal caused by the changes in the coal market, the coal terminal with extraordinary capital investment and specificity seems a bit clumsy. Once it cannot keep up with fast-changing coal markets, it may fall into a closed or even abandoned situation. In addition, coal's alternative energy sources of wind and solar energy do not get the need to transport

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raw materials, which will cause the entire coal transportation market to shrink, and inevitably exacerbate the oversupply of the terminal. To help the coal terminal response to possible market changes, this section will explore the transformation direction of the coal terminal.

4.1 Upgrade to a smart green coal port

Regardless of the fact that new energy will replace coal on a large scale in the future, coal transportation still has a certain amount of demand. The demand is mainly reflected in two aspects: First, as the research and development of carbon capture and storage (CCS) technology and hybrid power system becomes mature, carbon-free or low-carbon coal-fired power generation becomes possible, thermal power will retain a certain share; Second, the steel and chemical industries required for infrastructure construction in the emerging Asian countries like India still need to import coal and coke resources. However, shrinking demand will inevitably lead to competition among coal terminals. The transformation and upgrading to a smart green coal terminal are the key to success.

The smart and green coal terminal refers to the coal terminal that can realize the process of production automation, management informatization and ecological green operation, and also can realize the all-round and efficient management of material flow, energy flow and information flow, and ensure the efficient operation of the terminal, making the economic activities coordinated with the environment. Upgrading to a smart green coal terminal requires upgrading equipment automation, improving infrastructure information, promoting eco-environmental intelligence and enhancing intelligent application capabilities, and transforming traditional business-oriented management ideas into data-centric intelligent management ideas.

4.2 Reconstruction for other purpose

In addition to new construction, retrofitting existing terminals and storage facilities is a key way to improve port capacity. The construction of the coal terminal not only requires the purchase of specialized loading and unloading equipment, but also its geographical location, shoreline approval, yard, collection and distribution system, and even the waterway. Therefore, according to the actual market demand, the transformation of backward or surplus coal terminal capacity can make full advantage of port resources, improve the environment and enhance port competitiveness.

It is common to renovate the terminal according to market demand. Driven by demand for iron ore export bans and increased demand for coal in the region, Ennore Port on the east coast of India is being expanded. The expansion includes the transformation of an iron ore terminal with a capacity of 6mtpa into coal import terminal. It greatly improved the utilization rate of the port; The Beilun district of Ningbo-Zhoushan port transformed the coal terminal into a multi-purpose terminal,

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effectively improving the throughput capacity of Ningbo-Zhoushan Port's domestic trade container and general cargo, and further promoting port function integration.

4.3 Transformed into comprehensive urban functional zones

Coal plays an important role in providing energy in the development of numerous cities, and the coal terminal is the witness. The industrial sites such as power plants, docks, railways and loading and unloading equipment in the dock area are significant cultural assets of the city. Transforming the coal terminal into a residential area and transforming the industrial production facilities into a living and leisure space can make it become a unique cultural heritage of the modern city.

UK's Newcastle Docklands have prospered with coal mines and have been ruined by the decline of traditional manufacturing, but functional transformation and regional transformation has made it one of the UK's greatest city riverfronts. In addition to the reconstruction of residential areas and commercial functional areas, the Newcastle Quay area makes full use of the old wharf ruins and creates a cultural activity centre such as the Baltic Contemporary Art Center, which integrates the historical accumulation of the dock area into the contemporary urban space. In addition, Minsheng Wharf in Pudong, Shanghai transforms the original warehouse space into art and living space. The experience of transforming modern industrial sites such as power plants and old docks into green eco-tourism shoreline at the old dock in Xigang District of Qinhuangdao Port is also worth learning.

5. Conclusion

The main contributions of this article:

(1) Proposes a method to describe the supply and demand situation of coal terminals with the concept of adaptability, and classified its state into four types: shortage, adaptive, excess, and redundant.

(2) Describe the distribution of major coal terminals around the world and use the adaptability to describe the current supply and demand situation of major coal terminals in various regions.

(3) Discussing several transformation directions of coal terminals in light of the current trends.

Through the above research, the article concludes that with the decline of the coal market, the coal terminal is generally in an oversupply situation, and the transformation and upgrading are beginning to emerge.

The conclusions obtained in this paper enable readers to have a clearer understanding of the distribution and supply and demand of global coal terminals. At the same time, it will help terminal operators to seize the opportunities for transformation in the background of the continuous development of new energy. There is still room for improvement in the work of this paper. For example, some of

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the data required for adaptability calculation is difficult to obtain. In the future, we will hope to collect data such as the design handling capacity and the actual throughput of the terminal through other methods to obtain more accurate terminal fitness.

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