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Economic Analysis on Life Extension Operation of Coal-fired Units

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Abstract

Economic analysis is an important means to evaluate whether the life extension operation of Coal-fired units is feasible. In the paper, two typical Coal-fired units whose service life is 10 years and 30 years respectively are taken as the research object. Analysis focuses on the economy and feasibility of life extension operation of Coal-fired units. Results show that, the average energy cost (LCOE) of old Coal-fired unit with extended operation for 10 and 20 years is 0.23091 yuan/KW-h and 0.22816 yuan/KW-h. While LCOE of the new Coal-fired unit is 0.23272 yuan/KW-h. Therefore, life extension operation of Coal-fired units is economical and feasible.

Keywords

Economic Analysis; Coal-fired Unit; Life Extension; Average Energy Cost.

1. Introduction

With the increasingly stringent environmental protection policies, some researchers believe that small and medium-sized Coal-fired units should be eliminated and replaced by new units with large capacity and high parameters. Clean energy such as wind power and photovoltaic is used to replace coal energy[1]. However, China's power industry will still be dominated by coal in a long period of time. And China has issued a series of policies to solve the contradiction between regional coal supply and demand[2,3].

At present, the potential of Coal-fired units in China has not been fully utilized. The existing units have short operation time and low utilization efficiency. And the loss of our country coal power enterprise is above 50%. If new Coal-fired units are built, high coal price and low utilization efficiency will aggravate the long-term loss and bankruptcy crisis of coal power enterprises. The demolition of old units and the construction of new units is a process with high energy consumption and pollution. In the context of excess Coal-fired power generation, continued large-scale investment in Coal-fired power generation will squeeze the market share of clean energy and hinder the reform of China's energy structure.

This paper comprehensively compares the LCOE of a new Coal-fired unit of about 10 years and an old unit of about 30 years from an economic point of view, and discusses the main determinants of the cost.

2. Economic Analysis on Life Extension Operation of Coal-fired Power Unit

In the paper, LCOE index is mainly considered for the economic analysis of the life extension operation of Coal-fired units. And pollution costs such as pollutant tax and carbon emission are excluded.

2.1. Cost Model

The LCOE is the most widely accepted indicator for analyzing the power generation cost of a power plant, which represents the ratio of all costs to the total power generation during the operation period. The calculation of economic cost takes into account the time value of capital,

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the different discount coefficients of costs and power generation in different service years. The commonly used formula for calculating the LCOE is:

$$LCOE = \left(\sum_{n=1}^{N} \frac{(CAPEX_n + OPEX_n)}{(1+r)^n} \right) \Bigg/ \left(\sum_{n=1}^{N} \frac{\left(C \times H \times (1-o_u)\right)_n}{(1+r)^n} \right) \quad (1)$$

$CAPEX_n$ is the annual value of initial investment cost, including self-owned capital, loans and depreciation; $OPEX_n$ is the annual value of operation and maintenance costs, including fuel, operation and maintenance costs, insurance costs, and labor costs, etc.; C, H, o_u, N, r indicate installed capacity, annual utilization hours, power consumption rate, power plant operating life and discount rate respectively.

2.2. Cost Comparison between Life-extension Unit and Newly-built Unit

In this section, two representative Coal-fired units, Hanchuan-1 and Hanchuan-5, are selected to compare the costs of Life-extension units and Newly-built units. Hanchuan-1 was put into production in July 1990 and will reach the decommissioning age of 30 years, which is defined as the decommissioned unit. Hanchuan-5 was put into production in December 2012 and its service life is less than 10 years, which is defined as the Newly-built unit.

Table 1. Comparison of LCOE between Life-extension unit and Newly-built unit

Items	10 years life extension of decommissioned unit	20 years life extension of decommissioned unit	Newly-built unit with a 20-year service
Total investment of life extension/Newly-built(Thousand yuan)	390350	390350	3866838.7
Capacity(MW)	330	330	1000
Annual coal costs (Thousand yuan)	2716899.8	2675370.5	9213813.1
Annual environmental tax and fees (Thousand yuan)	14820	14820	27008.8
Annual CO2 emissions(ton)	3982791.43	3982791.43	11937722.22
Annual operation and maintenance costs(Thousand yuan)	39673.8	39673.8	53485.7
Annual labor cost(Thousand yuan)	30820.4	51162	144657.7
Annual electricity sales (KW-h)	12300520000	12300520000	43872560000
Power consumption rate(%)	0.0709	0.0709	0.0472
Discount rate(%)	6%	6%	6%
LCOE(Yuan/KW-h)	0.23091	0.22816	0.23272
LEOE(Yuan/KW-h)	0.01578	0.01578	0.01363
Total cost per kW-h(Yuan/KW-h)	0.24669	0.24394	0.24635

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The LCOE of Hanchuan-1 extending for 10 years and 20 years, as well as Hanchuan-5 operating for 20 years are calculated respectively. Results are shown in Table 1. From the perspective of installed capacity, the Newly-built unit Hanchuan-5 is about three times that of the decommissioned unit Hanchuan-1. Hanchuan-5 plays an important role in basic power supply as a Newly-built unit with a large capacity. However, the LCOE of Hanchuan-1 with extended operation for 10 years is 0.23091 yuan/KW-h. And the cost of the unit with extended operation for 20 years is 0.22816 yuan/KW-h. Both of them are lower than that of the Newly-built unit Hanchuan-5, which is 0.23272 yuan/KW-h. The difference mainly comes from the coal consumption of power generation, the investment in technical transformation of unit life extension and the investment in new construction. In addition, operation and maintenance costs as well as labor costs are also the main reasons for this difference.

In addition to undertaking basic load tasks, Coal-fired units also have functions of peak load regulation, heat supply, standby power supply (heat source), etc. If large units are used to replace small units for peak shaving, frequency regulation and heating, their operating conditions will inevitably be reduced, resulting in increased coal consumption, which will not only increase the economic cost, but also cause the problem of excess capacity of coal and electricity and waste of resources.

3. Summary

The LCOE of the unit with extended life is lower than that of the new unit. Generally speaking, life extension units have better economic results. Therefore, Coal-fired units, especially heating Coal-fired units, should not be shut down blindly. Instead, we should make a comprehensive evaluation from the aspects of energy conservation and emission reduction effect of the whole society, the overall efficiency of the power system, the safety of the power system and the whole life cycle of Coal-fired power units. On the premise of safe production, we should fully tap the potential of existing Coal-fired power units.

References

[1] Gu Y, Xu J, Chen D, et al. Overall review of peak shaving for Coal-fired power units in China. Renewable and sustainable energy reviews, 2016,54:722-731.

[2] Cao Fang. Research on planning method to wind farm and pumped-storage generation capacity. Beijing: North China Electric Power University, 2013.

[3] Xu J, Gu Y , Chen D , et al. Data mining based plant-level load dispatching strategy for the Coal-fired power plant coal-saving: A case study. Applied Thermal Engineering, 2017, 119(Complete):552-559.