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ScienceDirect
Energy Procedia 5 (2011) 2072–2077
Energy Procedia

IACEED2010

Site selection and scale measurement of regional coal reserves: taking Jiangsu Province as an example

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Abstract

The frequent coal shortages have widely aroused attention to the construction of coal reserve system, some coal reserve bases have been established in many provinces. But researches are few on site selection and scale measurement. With references to the researches on oil reserves, the paper first explored the influential factors on the site selection of regional coal reserves, taking Jiangsu Province as an example, three coal reserve bases should be built in Nanjing, Xuzhou and Lianyungang to ensure the coal supply. Then, learning from the researches on coal resources reserves and grain reserves, a general approach to calculate the scale of regional coal reserves was given, then, taking the direct-supply power plant in Jiangsu as an example, the scale of coal reserves were estimated with the fluctuation range of stock volatility (0, 0), (+1%, -1%), (+5%, -5%), (+10%, -10%), suggesting that the biggest dynamic reserves of 301,800 tons be moderate, with the fluctuation range of stock volatility (+5%, -5%). The research has important significance to promote the construction of regional coal reserve system.

Selection and peer-review under responsibility of RIUDS

Key words: Regional coal reserves; Site selection; Scale measurement

1. Introduction

Coal has accounted for 70% in Chinese energy consumption, which determines the strategic role of coal supply in the national economy. However, it is the long-distance transportation of coal in large scales, conflicts between coal industry and power industry, frequent natural disasters and other reasons that destroy the stability and balance of coal supply, which can be fully realized when snow storms came in early 2008, disastrous weather lasted from the end of 2009 to early 2010. To cope with time-interval coal

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doi:10.1016/j.egypro.2011.03.357

shortage, regional shortage of coal as well as shortage caused by coal varieties, the construction of coal reserve system has aroused attention of the state and local government. As the regional differences among the conditions of coal production, consumption and transportation are so obvious that the construction of coal reserve system will focus on regional coal reserves. [1]Though the central government hasn't made corresponding policies, the construction of coal reserve system has already started in some provinces which large amount of coal will be transferred to. Here are some examples: In 2006, Beijing started the construction of its first 0.3-million-ton coal reserve base; In October 2008, Shandong announced that, as a long-term target, a 50-million-ton reserve base for coal distribution would be built in Longkou; In early 2010, Hubei proposed that two provincial reserve bases be built in Zhichen and Yangluo. Both Zhoushan of Zhejiang and Longkou of Shandong had made great contribution to avoiding coal shortage from the end of 2009 to early 2010. Though we can see the construction of coal reserve bases has already started, few researches have been done on site selection and scale measurement of regional coal reserves.

2. Site selection of regional coal reserves

2.1 Influential factors on site selection of regional coal reserves

Site selection is an important decision for the construction of regional coal reserve system. For a specific region, the more reserve bases with more intensive layout will provide more secure coal supply and cost more, and vice versa. Therefore, the layout of regional coal reserves should adhere to the principles of proper centralization so as to realize the scale merit of coal reserve as well as convenient management. And for location of coal reserve bases, it is the reliability of source of coal, high efficiency of reserves use, and advantages of natural conditions that should be taken into consideration.

（1）Reliability of source of coal. It should be ensured that reserve bases can get coal in time, which requires steady coal production and dependable transportation. Under normal situation, coal reserve is dynamic and plays the role as coal logistics. Therefore coal reserve bases need to make good cooperation with coal-product enterprises for keeping coal supply steady. In addition, as railways and ports are the essential parts of China's coal transportation system, coal reserve bases should be located near to the ports which can connect to the main railway for coal transportation.

（2）High efficiency of reserves use. High efficiency of coal reserves use means the coal stored in the reserve bases can be sent to coal consumption centers in a short time to cope with sudden events such as coal shortages when coal supplies are interrupted. Therefore, to realize high efficiency of reserves use, the scope of radiation should not be too extensive. From reserve bases to coal consumption centers, the distance and transportation should be suitable.

（3）Advantages of natural conditions. Natural conditions always have great effects on coal storage. For instance, dry and hot weather easily leads to self-ignition of coal, while storage of close type may cause coal-dust explosion; Moisture in coal may be in excess of the standards on rainy days that will influence burning efficiency; Strong wind will blow off coal dust everywhere which leads to environmental pollutions and a waste of resource; The rain and snow make coal melt and the lost coal may cause water pollution; Coal will freeze and its normal turnover will be destroyed on frozen day. And possible situations are much more than we list above. So advantages of natural conditions should be taken into consideration during the stage of construction of coal reserve bases. And neither those areas with too much rain nor those with little rain can be the suitable places for coal reserve.

2.2 The site selection of regional coal reserves—take Jiangsu Province as an example

With Jinghu and Longhai railways across the four points of compass, Jiangsu Province enjoys excellent position and convenient transportation. It is a coastal province, with many high-level ports. All the advantages of Jiangsu has laid good foundation for construction of coal reserve bases. Combined with its production, transportation, and consumption of coal, this paper suggested three big coal reserve bases be built in Nanjing, Xuzhou and Lianyungang(Fig.1). Ports in Nantong, Suzhou, Zhenjiang and Yangzhou, which can't directly get coal from coal production bases, should be used to receive or discharge for the fact that the coal supply is not steady. If coal reserve bases lay in the ports listed out above, it will increase the costs of coal transfer as the direction of the flow of emergency coal supply are reversed. The rationality of suggestions given above will be explained below.

Fig.1. Coal reserve bases in Jiangsu Province and their scope of radiation

（1）Nanjing coal reserve base. For the construction of coal reserve bases, Nanjing, as the capital of Jiangsu Province, enjoys excellent conditions, especially for Nanjing Port locates in the important part of the "Golden Way" of Yangtze River, which is the key conjunction of routes for coal transportation in China. Nanjing Port can not only absorb coal but also discharge coal. Firstly, from the reliability of source of coal, Nanjing Port can absorb coal from Shanxi, Shandong, Anhui and Shaanxi Province, through Jinpu, Ninwan and Ninxi railways. Secondly, considering the efficiency of reserves use, bases of coal reserve in Nanjing can meet emergency demands, transporting coal through Yangtze River and next Huning railway, to Suzhou, Wuxi, Changzhou, Zhenjiang and other areas in south of Jiangsu Province.

（2）Xuzhou coal reserve base. Xuzhou is the important transportation conjunction in China and its coal logistics can offer relatively preferable services for Jiangsu Province. Firstly, from the reliability of source of coal, Xuzhou is the only coal product area in Jiangsu Province with about 20-million-ton annual output. And coal can be carried to Xuzhou from Shanxi, Shaanxi, Henan, Shandong, and other provinces, through Longhai and Jinghu railways. Secondly, considering the efficiency of reserves use, the coal in Xuzhou base can be transported to consumers through Jinghang canal and Jinghu railway. Especially, it is obvious that Jinghang canal has excellent advantages for the fact that it can transport 80 million tons coal now. And it is predicted that the canal will realize coal transportation with the scale over 150 million tons in 2020. The emergency coal in Xuzhou base can ensure the supply for northern areas in Jiangsu as well as middle and south areas, transported through Jinghang canal.

（3）Lianyungang coal reserve base. Lianyungang, as the biggest seaport in Jiangsu Province, is the most economical and convenient access to the open seas in south and middle-west of Jiangsu. Firstly, from the reliability of source of coal, through Longhai railway, to keep stable coal supply, this base can directly connect to large coal product provinces such as Shanxi and Henan. Besides, it can also get coal from some northern ports if necessary. Secondly, considering the efficiency of reserves use, while facing sudden coal shortages, through water transportation, this reserve base can not only ensure the coal supply for local consumers, but also for the consumers located along the coast, or the Yangtze River.

From the layout of coal reserve bases, along the Yangtze River, Jinghang canal and the coast in Jiangsu Province, it will form a “triangle-shaped” pattern if the three big coal reserve bases are respectively built in Nanjing, Xuzhou and Lianyungang. When sudden coal shortages occur, Nanjing coal reserve base will supply coal for cities, namely Nanjing, Zhenjiang, Suzhou, Wuxi, which are located along the Yangtze River or in the south of Jiangsu Province; Xuzhou coal reserve base will supply coal for cities, namely Xuzhou, Suqian, Huai’an, Yangzhou, Taizhou, which are located in the north and middle of Jiangsu Province or along the Jinghang canal; Lianyungang coal reserve base will mainly supply coal for cities, namely Lianyungang, Yancheng, Nantong, which are located along the coast.

3. Scale measurement of regional coal reserves

3.1 Approach to scale measurement of regional coal reserves

Generally speaking, the larger scale brings the higher reserve cost and higher level of safeguard, and vice versa. Therefore, while making decision for the reserve scale, we should weigh and judge the reserve cost and profit. To cope with sudden coal shortages, we should realize that the scale of regional coal reserves depends on the following two factors: one is the probability of sudden events, which means the more frequent coal shortages needs more coal reserves; another is consumption scale of coal, which means the larger consumption scale needs more coal reserve to ensure coal supply. Learning from the researches on specific reserves of coal resources and grain reserves[2][3], with balance of stock volatility, stock volatility index and safe fluctuation range of stock volatility considered synthetically, the approach to scale measurement of coal reserve can be defined as:

$$R_t = \begin{cases} (I_t - I_0)(1-\alpha / v_t) & (0 \le \alpha < v_t) \\ 0 & (\beta \le v_t \le \alpha) \\ (I_t - I_0)(1-\beta / v_t) & (v_t < \beta \le 0) \end{cases} \qquad M_t = \left| R_t \right| \tag{1}$$

In the formula, R_t equals the reserve of the t period, the positive signs stand for absorbing coal reserve, while the negative signs stand for releasing coal reserve; M_t equals the absolute reserve of the t period; （α，β）is the fluctuation range of stock volatility which reflects the safe supply level and reserve costs under a certain amount of reserves; I_t- I_0 and V_t respectively stands for balance of coal stock volatility and stock volatility index. And the balance of coals stock volatility equals the difference between actual stock and basic stock, which can be expressed as $\Delta I_t=I_t- I_0$, I_t is actual stock, while I_0 stands for the stock under normal circumstance and in this paper I_0 is expressed as the basic stock. As a certain cycle is needed for adjustment of coal stock, we can define the basic coal stock as the function of the previous coal stock, which can be expressed as $y_t=a+by_{t-1}$. Stock volatility index can be expressed as $V_t=[(I_t- I_0)/ I_0]\times100\%$, which can reflect the departure degree of actual coal stock from the basic coal stock.

3.2 Case study of scale measurement of regional coal reserves

Taking stock volatility and necessary dynamic reserves of a direct-supply power plant in Jiangsu as an example, this paper estimated the scale of reserve and provided a simulation, which especially focused on ensuring the coal supply for the main power plants, coupled with considering the availability of data during the case study. According to the data from http://www.cctd.com.cn/, collected from April 6, 2009 to April 11, 2010, using the calculation formula given above for basic stock, the trend function of basic stock for the sample plant can be obtained as y_t=17.367+0.948y_{t-1}, R=0.945, T test value is 17.881.

Table 1 Different dynamic reserves for different fluctuation ranges of stock volatility

Date	y_t	y*	v_t	R_t			
				(0，0)	(1%，-1%)	(5%，-5%)	(10%，-10%)
April 12, 2009	325.51	332.55	-2.12%	-7.04	-3.72	0.00	0.00
April 20, 2009	339.68	325.95	4.21%	13.73	10.47	0.00	0.00
April 27, 2009	356.37	339.39	5.01%	16.98	13.59	0.03	0.00
April 29, 2009	370.93	355.21	4.43%	15.72	12.17	0.00	0.00
May 18, 2009	387.19	369.01	4.93%	18.18	14.49	0.00	0.00
May 25, 2009	399.36	384.42	3.89%	14.94	11.10	0.00	0.00
May 30, 2009	419.73	395.96	6.00%	23.77	19.81	3.96	0.00
June 9, 2009	410.22	415.27	-1.22%	-5.05	-0.91	0.00	0.00
June 21, 2009	404.34	406.26	-0.47%	-1.92	0.00	0.00	0.00
June 28, 2009	420.34	400.68	4.91%	19.66	15.66	0.00	0.00
July 12, 2009	413.79	415.85	-0.50%	-2.06	0.00	0.00	0.00
July 26, 2009	391.86	409.64	-4.34%	-17.78	-13.68	0.00	0.00
July 28, 2009	412.17	388.85	6.00%	23.32	19.43	3.89	0.00
August 10, 2009	397.00	408.11	-2.72%	-11.11	-7.03	0.00	0.00
August 17, 2009	392.23	393.72	-0.38%	-1.49	0.00	0.00	0.00
August 25, 2009	392.23	389.20	0.78%	3.03	0.00	0.00	0.00
August 31, 2009	354.30	389.20	-8.97%	-34.90	-31.01	-7.25	0.00
September 6, 2009	367.11	353.24	3.93%	13.87	10.34	0.00	0.00
September 20, 2009	344.54	365.39	-5.71%	-20.85	-17.20	-2.56	0.00
October 9, 2009	287.37	343.99	-16.46%	-56.62	-53.18	-29.86	-22.22
October 18, 2009	282.84	289.80	-2.40%	-6.96	-4.06	0.00	0.00
October 29, 2009	255.93	285.50	-10.36%	-29.57	-26.72	-13.09	-1.03
November 9, 2009	216.64	259.99	-16.68%	-43.35	-40.75	-30.18	-17.36
November 22, 2009	184.79	222.74	-17.04%	-37.95	-35.72	-26.57	-15.68
November 28, 2009	180.95	192.54	-6.02%	-11.59	-9.66	-1.44	0.00
November 30, 2009	190.63	188.91	0.91%	1.72	0.00	0.00	0.00
December 3, 2009	177.13	198.08	-10.58%	-20.95	-18.97	-10.84	-1.15
December 8, 2009	199.33	185.29	7.58%	14.04	12.19	4.78	0.00
December 17, 2009	193.32	206.34	-6.31%	-13.02	-10.96	-2.21	0.00
December 28, 2009	189.19	200.63	-5.70%	-11.44	-9.43	-0.46	0.00
January 17, 2010	199.28	196.72	1.30%	2.56	0.59	0.00	0.00
January 28, 2010	210.29	206.28	1.94%	4.01	1.94	0.00	0.00
February 3, 2010**	255.11	216.72	17.71%	-	-	-	-
February 21, 2010*	374.90	259.21	44.63%	-	-	-	-
February 28, 2010	366.11	372.77	-1.79%	-6.66	-2.94	0.00	0.00
March 14, 2010	366.39	364.44	0.54%	1.95	0.00	0.00	0.00
March 21, 2010	345.71	364.70	-5.21%	-18.99	-15.35	2.89	0.00
March 28, 2010	350.63	345.10	1.60%	5.53	2.07	0.00	0.00
April 4, 2010	346.96	349.76	-0.80%	-2.80	0.00	0.00	0.00
April 11, 2010	360.86	346.29	4.21%	14.57	11.11	0.00	0.00

Note：negative signs stand for discharging coal reserve, positive signs stand for absorbing coal reserve

According to the calculation approach of scale of coal reserve provided above, the scale of coal reserve were estimated with the fluctuation range of stock volatility (0, 0) , (+1%, -1%), (+5%, -5%), (+10%, -10%) (Table 1). Among the results, stock volatility (0, 0) means stock volatility will be thoroughly eliminated to ensure normal operation of national economy; stock volatility （+1%，-1%） means the

* On February 3 and February 21, the sudden increase of coal stock was caused by the emergency allocation and transport of coal organized by the Ministry of Railways and the Ministry of Communications to cope with the coal shortages in East China, the stock volatility index and the corresponding dynamic reserves in the two special days have not been taken into consideration in this paper.

fluctuation will be largely eliminated, which may have slight impact on economic operation; stock volatility（+5%，-5%）means the fluctuation will be slightly eliminated and also may have slight impact on national economy; while stock volatility（+10%，-10%）means the dynamic reserve makes little contribution to eliminate stock volatility, which will have greater impact on national economy. From the above reserve programs, it can be concluded that costs and reserve will come down with the expansion of fluctuation range. Meanwhile, it will have greater impact on normal operation of national economy. Comprehensively taking costs of reserve and supply security into consideration, with the four sorts of fluctuation range mentioned above, this paper argues that the stock volatility（+5%，-5%) is the most suitable range of fluctuation for the scale of coal reserves. Under such circumstances, to ensure coal supply, for this direct-supply power plant in Jiangsu, the maximum dynamic reserve should correspondingly reach 301,800 tons.

4. Conclusion

Focusing on coal supply security, to both governments and scholars, it is the consensus that coal reserve bases should be built along coasts, rivers and roads in Central China, East China and South China. However, the relevant researches relatively lag behind, while this paper discussed about site selection and scale measurement of regional coal reserves, which has drawn the following conclusion:

（1）It is suggested that the security and economic effectiveness of the layout of regional coal reserve should be mainly weighed and judged, and also should adhere to the “proper centralization” principle. And for site selection of reserve based, it is the following influential factors like reliability of source of coal, the efficiency of coal use and the natural advantages that should be mainly considered. Referring to these factors, taking Jiangsu Province as an example, this paper suggested that three large reserve bases should be built in Nanjing, Xuzhou and Lianyungang in order to meet the emergency demand of coal.

（2）As considering that the scale of regional coal reserves mainly depends on the consumption scale and stock volatility, this paper provided the approach to calculate the scale of coal reserves. In details, first with a direct-supply power plant in Jiangsu cited as an example, this paper calculated the scale of dynamic reserves for different fluctuation ranges of stock volatility. The data was collected from April 6, 2009 to April 11, 2010. This paper suggested that the reserve scale ,with the stock volatility（+5%，-5）, is the relatively suitable and adoptable one, which has a maximum dynamic reserve of 301,800 tons.

Acknowledgements

The authors are grateful to the National Soft Science Foundation and Jiangsu Soft Science Research Plan for financial support (No. 2010GXQ5D331 and No. BR2010007).

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