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Viewpoint

Energy saving and emission reduction: A project of coal-resource integration in Shanxi Province, China

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ABSTRACT

The small or middle coal mines with illegal operations in developing countries or regions can cause bad energy waste and environmental disruption. The project of coal-resource integration in Shanxi Province of China gives a new idea or an approach to energy saving and emission reduction. It is a social- and economic-ecological project. The paper shows the targets of energy saving and emission reduction in Shanxi Province, and analyses the aims, significance, design process and implementation of the integration project. Based on that, the paper discusses the challenges and opportunities the project brings. The analysis shows that the project of coal-resource integration in developing countries or regions can effectively improve mining technologies, collect capital and impel international cooperation and exchange. Finally, the paper analyses the concerns about the future, including the possible problems of implementation period, industrial updating, environmental impact and re-employment. However, the successful integration of coal resources can mitigate energy crisis and climate crisis and promote cleaner production effectively.

1. Introduction

The energy saving and emission reduction has become a common endeavor in the world to sustain human development. Many countries' governments and organizations have been taking a series of actions, including techniques, policies, engineering and economic approaches, such as the application of emission allowances and energy system in the production of plants (Zanganeh and Shafeen, 2007; Ribbenhed et al., 2008), the development of cleaner vehicles and energy efficiency standards (Nakata, 2003; Mahlia and Yanti, 2010) and the use of improved materials and new fuels (Hekkert et al., 2000; Stehlík, 2009; Wang et al., 2009; Joelsson and Gustavsson, 2010).

China is the largest developing country in the world. The president of China, Jintao Hu, expounded China's stance on tackling climate change at the 15th Economic Leaders' Meeting of the Asia-Pacific Economic Cooperation (APEC) forum. China's action in energy saving and emission reduction draws global attention. As one of the largest energy and industrial base in China, Shanxi Province covers only 1/60 of the territory of China but its coal production accounts for 1/4 of China's total, coke production for 2/5 and power generation for 1/17 (Liu, 2009). To achieve Shanxi's targets of reducing energy consumption per unit of GDP by 25% and emissions of SO_2 by 14% and COD by 13% during China's Tenth 5-Year Plan (2006–2010; Cui, 2007), Shanxi government has been adopting some policies and measurements (Shanxi Provincial People's Government, 2007). According to the provincial statistics from 2005 to 2009 on the official websites of the Central People's Government of the People's Republic of China and the National Bureau of Statistics of China, during the first 4 years of China's Tenth 5-Year Plan, the energy consumption per unit of GDP in Shanxi cumulatively reduced by 19.75%, accounting for 89.77% of the overall target (22%). In addition, the emissions of SO_2 and COD were reduced by 16.35% (surpassing the overall target) and 10.98% (accounting for 84.46% of the overall target), respectively (Fig. 1). The achievement benefited from the closure or elimination of low-productivity industries and the control of pollutants' emission. As an effective trial and demonstration, the strong coal-resource integration of Shanxi in 2009 attracts the whole China's and even global eyes.

2. A social- and economic-ecological project

The integration of coal resources has focused the efforts on two aspects: economic sustainability and ecological improvement. The integration in Shanxi Province aims at pursuing

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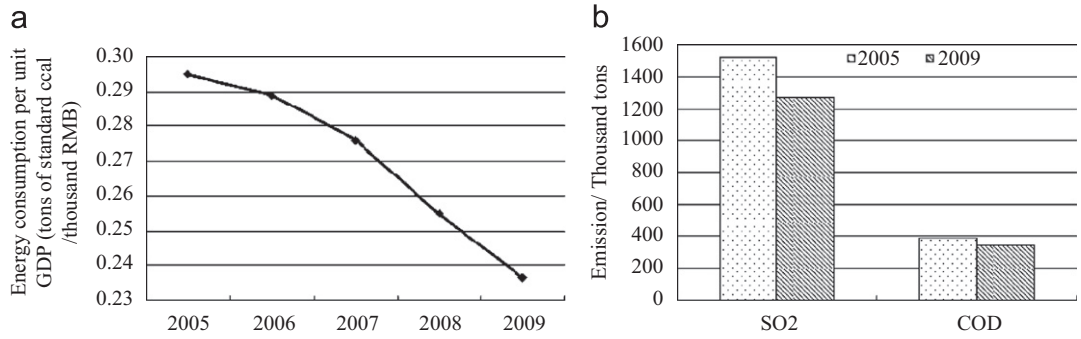

Fig. 1. Achievements of energy saving and emission reduction in Shanxi Province, China: (a) energy saving and (b) emission reduction.

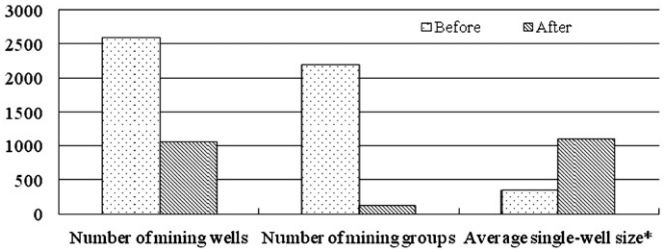

Fig. 2. Achievements of coal-resource integration in Shanxi Province of China (Leadership Office of Coal Mine Corporation Merger and Coal-Resource Integration of Shanxi, 2009b; People Website, 2009.) * Unit of average single-well size is thousand tons/a.

coal-mining scale extraction, mechanization, informatization and modernization (Leadership Office of Coal Mine Corporation Merger and Coal-Resource Integration of Shanxi, 2009a). To maximize coal-resource utilization and technological improvement, Shanxi government made three plans, including closure of small-scale mines, improvement of mining productivity and merger and acquisition of mining groups.

Before integration, the mines with annual production below 30,000 tons accounted for over 80%, but only 12% of them developed mechanized mining. After integration, the mines with annual production below 30,000 tons must be closed, and the rest will adopt mechanized mining technologies (Fig. 2); besides, (extra-) large mining groups were established, including 4 one hundred million-ton ones, 3 fifty million-ton ones and 10 ten million-ton ones (Leadership Office of Coal Mine Corporation Merger and Coal-Resource Integration of Shanxi, 2009b). For example, Lu'an Mining Group integrated 110 mines before integration into 40 mines, and the annual production of coal reached 41.10 million tons (General Office of Shanxi Provincial Party Committee, 2009).

The new mining groups need to make measurements for coal mining, such as mine designs, energy development plans, emission reduction plans and ecological restoration plans. As reported, China National Coal Group Corp., one of the (extra-) large mining groups in the coal-resource integration, has raised the mining percentage extraction up to 87.13% (Guo, 2009). However, the percentage extraction of small-scale mines is between only 15% and 20% (Wang and Liu, 2009). If calculated based on the annual production of 0.35 billion tons of coal resources by small-scale mines, Shanxi destroys and wastes over 1.4 billion tons of coal resources per year (Wang and Liu, 2009). For the percentage extraction up to 80–90% after integration, around four or five times of coal loss can be avoided while extracting one ton of coal. (Extra-) large mining groups also focus their efforts on reusing coal wastes. About ten million tons of coal slurry, gangues and fault coal are consumed by these groups for power generation every year (Guo, 2009). Additionally, Shanxi government sets up a series of regulations for environmental protection in the course of integrating coal resources, including operation scope and ecological compensation. Natural reserves, forest parks, spring areas and Fenhe River are prioritized for protection during the implementation of this project. Any mining activity must be prohibited and every mine must be restricted for development or even closed in these areas (Leadership Office of Coal Mine Corporation Merger and Coal-Resource Integration of Shanxi, 2009c).

3. Challenges and opportunities

As reported in the first half of 2009, Shanxi was the only province with a negative growth of GDP in China. "Black GDP" presents the major driving force for economic development in Shanxi. In the past, economic benefit was put ahead of energy consumption and ecological damage. Impacted by global economic crisis and domestic demand expansion, the coal-resource integration in Shanxi had to face unprecedented challenges: how to turn the extensive and unadvanced production mode to an intensive and advanced production one and how to integrate coal resources to keep a balance between economic sustainability and ecological improvement. Actually, Shanxi was challenging its traditional economic development mode. However, it is obvious that Shanxi government made up its mind to turn "black GDP" to "green GDP".

The small- and middle-scale mining groups (mines) have always made great contributions to regional energy needs and economic construction. Though many of these mines may survive in the global economic crisis, they also present a series of problems such as unadvanced technologies, scattered capital and low responsibility for energy saving, emission reduction and ecological restoration. In the areas where small- and middle-scale mines were distributed, mining land was always abandoned without any reclamation and air was polluted by waste gases and coal dusts (Fig. 3). In the background of economic globalization, these mining groups are easier to be forced out of business due to lack of competitiveness. With the fast development of China's economy and global marketization, integrated mining groups can deal with international economic and energy situations and sustain local environment better. The global economic crisis accelerated the coal-resource integration.

The greatest advantage in the coal-resource integration is to introduce and improve mining technologies and to collect capital. The integration is not a simple process but one of the complementary advantages within mines, with the aim of optimizing coal resources. According to statistics, over 12 billion m^3 of coke oven gas per year is generated during the operating process in Shanxi, but only 30% of them can be used and the rest is put into air. Some experts estimate that if the utilization rate of coke oven