Viewpoint

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

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A B S T R A C T

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.

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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; Stehlik, 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 SO2 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 SO2 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
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 m³ 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...
Currently, these (extra-) large mining groups are actively developing advanced technologies and cleaner production. Governments’ supports, gathered capital and technological cooperation have supplied the integrated mining groups with a new way to develop advanced technologies and cleaner production. Currently, these (extra-) large mining groups are actively developing and applying the techniques of coal desulfurization for SO2 emission reduction.

In addition, international cooperation and an introduction of advanced technologies create new conditions for entire technological enhancements of integrated mining groups. Jincheng Coal Industry Group, also one of the (extra-) large mining groups, carried out one new project of coal bed methane (CBM) power generation, which can reduce the emission of over 3 million tons of CO2 (Jiao, 2009). Under properly controlled conditions, various technologies for energy saving and emission reduction will be widely applied in the process of coal production in the future.

Another advantage of coal-resource integration is that special funds and research projects are used for damaged land reclamation and ecological restoration. Before integration the small- and middle-scale mining groups had insufficient funds and technologies to restore the damaged land, which always used to be left abandoned. Actually, only (extra-) large mining groups have enough financial, material and human resources to guarantee this task. Land reclamation plan must be taken into mine design and mining process. In the integration program of Lu’an Mining Group, another (extra-) large mining group, 8 RMB (approximately equal to 1.21 USD, 1 USD ≈ 6.59 RMB) per ton of coal sales is used for ecological compensation, geological hazard prevention and treatment (General Office of Shanxi Provincial Party Committee, 2009). In China, the damaged land is mainly reclaimed to farmland and forest land due to the national conditions; especially, pioneer tree selection in reclaimed forest land also has a great positive influence on the absorption of CO2 and SO2. Relevant research shows that every 1 m3 of lumber can absorb 1.83 tons of CO2 and release 1.62 tons of O2 approximately as forest grows (Zhang et al., 2010). From the angle of material and energy flows, land reclamation equals emission reduction.

4. Concerns about the future

Considerable attention is fixed on whether the project can be implemented for long, whether coal resources can be saved and whether the emission can be reduced significantly. The small- and middle-scale mines played a decisive role in the electric power supply against the snow damage of 2008 in the South China. So, will these mines be reworked one day? There is no doubt that large-scale mines can help local sustainable economy better. Shanxi government must make subsequent policies to guarantee the continued implementation of the project. Besides, the setup of emission baselines is important and effective for greenhouse gas emission reduction and for production activity regularization (Albrecht, 2001; Ádahl et al., 2004). Therefore, the local government must also set up a package of emission standards and monitoring measurements to reduce the solid wastes from coal mining and to control the emission of waste gases. The coal-resource integration is only the first step of the systematic project. More attention should be paid to investigation, design, production, monitoring and treatment before, during and after coal extraction.

Secondly, integration is promoting industrial upgrading. It is not a mechanical process of combining some/many mines but an access to improve mining technologies to save coal resources and reduce emission. Population growth and energy shortage are inevitable. Only the improvement of mining technologies can meet these needs effectively and significantly. The integrated (extra-) large mining groups must take technical integration and improvement as one of their efforts. Besides, the gathered capital can be used for technical improvement and ecological restoration.

Additionally, the impact of (extra-) large mining groups on land damage is, actually, not less than that by small- and middle-scale mining groups. In general, large mining equipment and large-scale coal production have more negative influences on land subsidence, land degradation, land pollution, surface cracks, etc. A new environmental issue becomes a new difficulty for the future of integrated mines. Therefore, the application and improvement of land reclamation technologies must be a main task in the future.

Another concern is that the integrated mining groups will face the re-arrangement of mine employees and miners. Due to the changes of property rights of mines, most of these people have to face unemployment or job transfer. This part of people, including their families, must be assigned to appropriate arrangement during the transition period of coal-resource integration. Related measurements must be set to guarantee local people’s living.

The project of the coal-resource integration is an arduous and difficult task. It raises a threshold for industry access. Rather, a technical threshold and an environmental threshold are set up as an expression of the integration. If integrated well, the new mines and mining groups will ultimately promote the economic, social and ecological sustainability of the whole Shanxi Province and accelerate the transformation of “black GDP” to “green GDP”. Currently, some other provinces in China sent representatives to do some investigations about the coal-resource integration in Shanxi. If tested successfully in Shanxi, this method of coal-resource integration will be expanded all over China. At that time, there may be two scenarios in mining areas after years—“mechanized mining operation” and “clear water and blue sky”. The past mining mode of dominant non-large-scale mining production is an indispensable process in developing countries. But these countries should also be responsible for emitted wastes. We hope that the influence of the project will not be remembered as only a project but for its positive social- and economic-ecological significance, and that it can give a good example of resource/energy integration to other developing countries and regions.

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